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ON THE COVER

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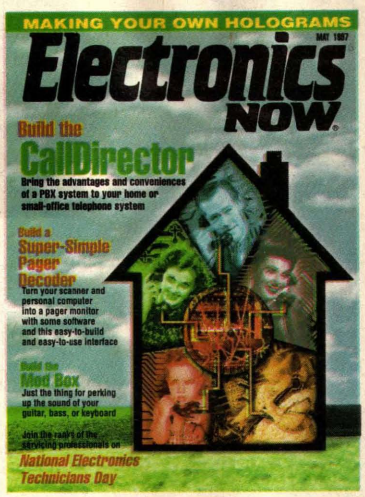
If you're like many, you probably have several telephones scattered around the house. After all, telephones are relatively inexpensive these days, and doing that can be a great convenience. That is, unless you answer a call in one part of the house that's intended for someone in another. Then, you have to find whomever the call is for, tell them to pick up the phone, and go back to the first phone and hang it up. If you have a teenager, or anyone else who gets a lot of calls, that can become a real nuisance. Well, while this month's cover story won't stop the phone from ringing, it can make the rest a lot easier to deal with. It is a PBX system that's ideal for a home or small office. Best of all, it uses the existing telephone wiring for easy installation. — *John G. Koller*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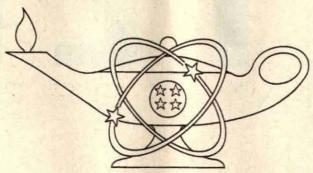

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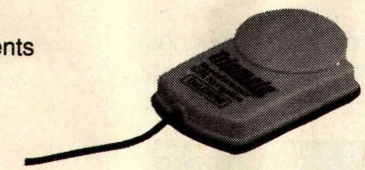

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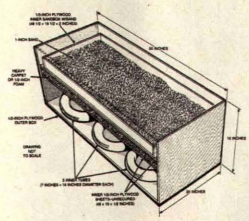

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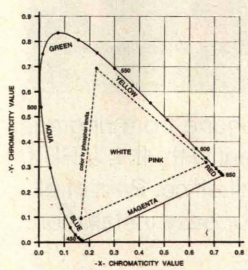

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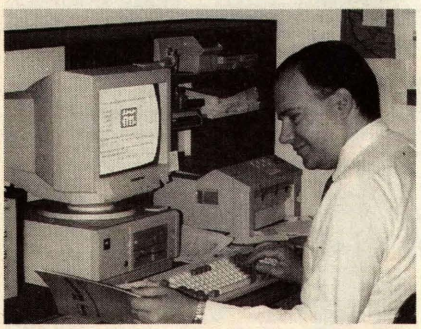

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EDITORIAL

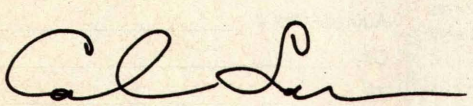
Recognizing the Servicing Professional

Increasingly, we are becoming a society that depends on technology to get even trivial tasks done. While that is not necessarily a bad thing, if that technology fails, it can bring society to its knees.

That's why it is more important than ever to have a ready cadre of individuals that are competent and capable of preventing failures before they happen, or restoring proper function in the shortest possible time in the event that they do. The problem lies in how to identify those types of individuals. After all, a mistake in judgment could be catastrophic.

Perhaps one of the best ways is to look for individuals who have demonstrated their knowledge and expertise by earning the title of Certified Electronics Technician, or CET. The CET title is not bestowed lightly. To get that recognition, a technician must have at least four years of formal training and work experience, plus pass a rigorous exam that covers both basic electronics theory and an area of specialization.

In recognition of those dedicated professionals, the International Society of Certified Electronics Technicians (ISCET) has declared April 22, 1997 as National Electronics Technicians Day. What's more, it is using that occasion to make it possible for many more technicians to join the ranks of the certified professionals. To find out more about that opportunity and how you can take advantage of it, see the story "National Electronics Technicians Day" on page 56.



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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Patent-Search Web Site

IBM has launched a free World Wide Web service for finding and viewing information contained in more than two-million U.S. patents granted since 1971. The Patent Server site (http://www.ibm.com/patents) allows anyone with Web access to search and retrieve information on patents and to view full images of close to one-million patents issued since 1987.

The server supports simple searching by patent number or by key words in certain patent information categories—title, inventor, assignee, abstract, claims, attorney/agent, and patent references—as well as more advanced searching using Boolean operators. Within any patent, references made to other U.S. patents are hyperlinked. Those links are bi-directional, allowing easy access to later patents that reference the document being viewed. Copies of patents can be ordered for a fee from Optipat, Inc., and delivered by mail, Fax, or on CD-ROM.

IBM plans to add in early 1997 the full images of patents issued between 1974 and 1986. Information and images of newly issued patents will be added to the database on a regular basis. Future plans for the site include expanding the patent server capabilities to allow searching of the full text of patents, international patent data, and links to other patent-information vendors.

The Patent Server site is an outgrowth of a capability that has been used for the past year by researchers and patent attorneys in IBM's Research Division. "It saved us time and money, so we thought it would be a valuable resource to the public as well," said Marshall Phelps, vice president IBM intellectual property and licensing. "Being able to view the patent images is especially important because so much critical information is contained in a patent's figures and drawings."

IBM expects that free access to such comprehensive information will hasten the pace of innovation across the board, because inventors can avoid inadvertently duplicating inventions that have already been patented. Another goal of the project is to create an easy-to-use digital archive prototype for making information available on the Web that might encourage other public- and private-sector organizations to create similar servers.

Biomass Power Plant/Nuclear Cleanup Proposal

A collaboration of private business and researchers from the United States and Belarus (an independent state and part of the former Soviet Union) plans to test a way to decontaminate the forests north of Chernobyl, site of the world's worst nuclear reactor accident—which spewed an estimated 2000 times as much radioactivity as the bombs dropped on Hiroshima and Nagasaki combined. The joint project will study the feasibility of generating electricity by burning the timber that harbors most of the radioactive residue and capturing the radioactive ash. The power-generating facility is known as a biomass power plant.

Belarus received about 70 percent of the fallout from the 1986 Chernobyl accident. Close to one-quarter of the country—primarily the heavily forested southeast portion—was severely contaminated. Although it is prohibited, residents gather food and collect firewood in the forests. Fallout is showing up in thyroid cancers and leukemia, particularly in children.

Researchers from Sandia National Laboratories (Albuquerque, NM) and the Institute of Power Engineering Problems (formerly part of the Soviet Academy of Sciences) will join with Wheelabrator Environmental Systems Inc. (Hampton, NH) to build the pilot biomass power plant. Besides contaminated trees, the plant will have to burn "duff"—the leaves, twigs, and humus from the forest floor—without releasing radioactive isotopes into the air. Radionuclides, primarily cesium and strontium, would be captured in the ash and disposed of as low-level waste.

Wheelabrator will conduct experiments burning uncontaminated duff at its commercial plant in Anderson, California. Sandia's Combustion Research Facility will model combustion characteristics and use computer simulation to determine which plant design would minimize the emission of small, hard-to-capture particles.

"The prime consideration is to not make the situation worse," said David Brekke, a Sandia health physicist. "If we can't do this in a safe and environmentally sound manner, it won't go."

If the project turns out to be feasible, it could take just 30 to 40 years to clear the contamination. Left alone, it would take hundreds of years for the region to return to acceptable levels of radioactivity.

Half of the $1.6 million expense for the two-year project is being contributed by Wheelabrator; Sandia and Belarus are equally sharing the other half. The money is being provided by the Department of Energy's Initiatives for Proliferation Prevention program, which is intended to deter nuclear proliferation by providing non-weapons-related work to scientists in the former Soviet Union.

KU TV Station Goes Online

KUJH, a University of Kansas (KU) television station that operates at 7.5 kilowatts of effective radiated power out of KU's William Allen White School of Journalism and Mass Communication, went online on December 10, 1996. Gary Hawke, general manager of the journalism school's Integrated Media Lab, believes the station to be the first in the country, if not the world, to offer round-the-clock news programming on the Internet.

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Budget Project and Computer Books

☐ **BP317–Practical Electronic Timing $6.95.** Time measurement projects are among the most constructed gadgets by hobbyists. This book provides the theory and backs it with a wide range of practical construction projects. Each project has how-it-works theory and how to check it for correct operation.

☐ **BP415–Using Netscape on the Internet $7.95.** BRAND NEW Get with the Internet and with surfing, or browsing, the World Wide Web, and with the Netscape Navigator in particular. The book explains: The Internet and how the World Wide Web fits into the general scenario; how do you go about getting an Internet connection of your own; how to download and install the various versions of Netscape browsing software that are available; and how to use Netscape Navigator to surf the Web, and to find and maintain lists of usful sites. There's a heck of a lot more, too!

☐ **BP325–A Concise User's Guide to Windows 3.1 $7.95.** Now you can manage Microsoft's Windows with confidence. Understand what hardware specification you need to run Windows 3.1 successfully, and how to install, customize, fine-tune and optimize your system. Then you'll get into understanding the Program Manager, File Manager and Print Manager. Next follows tips on the word processor, plus how to use Paintbrush. There's more on the Cardfile database with its auto-dial feature, Windows Calendar, Terminal, Notepad, etc.

☐ **BP327–DOS: One Step at a Time $5.95.** Although you spend most of your time working with a word processor, spreadsheet or database, and are probably quite happy using its file management facilities, there will be times when you absolutely need to use DOS to carry out 'housekeeping' functions. The book starts with an overview of DOS, and later chapters cover the commands for handling disks, directories and files.

☐ **PCP119–Electronic Music and Midi Projects $14.95.** Save cash by building the MIDI gadgets you need. Want a MIDI THRU box, program change pedal, Metronome, analog echo unit, MIDI patchbay or switcher? Over 16 practical and very useful music and MIDI projects—all in this book! The projects are explained in detail with full instructions on assembly.

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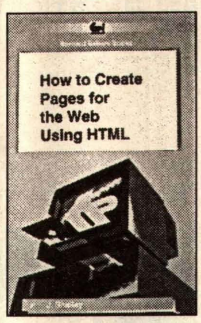

Companies around the world, as well as PC users, are fast becoming aware of the World Wide Web as a means of publishing information over the Internet. HTML is the language used to create documents for Web browsers such as Mosaic, Net-scape and the Internet Explorer. These programs recognize this language as the method used to format the text, insert images, create hypertext and fill-in forms. HTML is easy to learn and use. This book explains the main features of the language and suggests some principles of style and design. Within a few hours, you can create a personal Home Page, research paper, company profile, questionnaire, etc., for world-wide publication on the Web.

☐ **BP377—Practical Electronic Control Projects $6.95.** Electronic control theory is presented in simple, non-mathematical terms and is illustrated by many practical projects suitable for the student or hobbyist to build. Discover how to use sensors as an input to the control system, and how to provide output to lamps, heaters, solenoids, relays and motors. Also the text reveals how to use control circuits to link input to output including signal processing, control loops, and feedback. Computer-based control is explained by practical examples.

☐ **BP411—A Practical Introduction to Surface Mount Devices $5.95.** This book takes you from the simplest possible starting point to a high level of competence in working with Surface Mount Devices (SMD's). Surface mount hobby-type construction is ideal for constructing small projects. Subjects such as PCB design, chip control, soldering techniques and specialist tools for SMD are fully explained. Some useful constructional projects are included.

☐ **BP136—25 Simple Indoor and Window Aerials $5.50.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

☐ **BP336—A Concise User's Guide to Lotus 1-2-3 Release 3.4 $7.25.** Discover how to use a three-dimensional Lotus spreadsheet in the shortest and most effective way. The book explains how: to generate and manipulate 3-dimensional worksheets and how to link different files together; to generate and add graphs to a worksheet, edit them, and then preview and print the worksheet; to use the SmartIcons and become more productive with your time; to use the WYSIWYG add-in to produce top quality screen and printed displays; and much more.

☐ **BP379—30 Simple IC Terminal Block Projects $6.50.** Here are 30 easy-to-build IC projects almost anyone can build. Requiring an IC and a few additional components, the book's 'black-box' building technique enables and encourages the constructor to progress to more advanced projects. Some of which are: timer projects, op-amp projects, counter projects, NAND-gate projects, and more.

☐ **BP401—Transistor Data Tables $6.95.** The tables in this book contain information about the package shape, pin connections and basic electrical data for each of the many thousands of transistors listed. The data includes maximum reverse voltage, forward current and power dissipation, current gain and forward transadmittance and resistance, cut-off frequency and details of applications.

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☐ **BP92—Electronics Simplified: Crystal Set Construction $2.69.** This book is written for those who wish to participate in electronics more through practical construction than by theoretical study. It is designed for all ages upwards from the day when one can read intelligently and handle simple tools. The crystal set projects are designed to use modern inexpensive components and home-wound coils. A book highly recommended for all newcomers.

☐ **ETT1—Wireless & Electrical Cyclopedia $5.75.** Step back to the 1920's with this reprinted catalog from the Electro Importing Company. Antiquity displayed on every page with items priced as low as 3 cents. Product descriptions include: Radio components, kits, motors and dynamos, Leyden jars, hot-wire meters, carbon mikes and more. The perfect gift for a radio antique collector.

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Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

8088 I/O Ports

Q *I recently started a project with an 8088 microprocessor as described in the "Drawing Board" column in your October 1995 issue. When I looked in the November issue, I saw that the Drawing Board column had been dropped and the rest of the project never appeared. I have a basic understanding of how to design the circuit but am not completely sure how to demultiplex the address and data lines. I would definitely like to know how to implement I/O ports and memory-mapped I/O. Any help you could give me would be greatly appreciated.—*
M. A., Shrewsbury, MA

A We regret very much that the promised columns weren't completed; some things are beyond a magazine's or an editor's control. Some related projects by the same author are in *The 8088 Project Book*, by Robert Grossblatt, published by TAB/McGraw-Hill, which you can order through any bookstore. Mean while, here's some information to get you started.

First, if you don't actually need 8088 software compatibility, you might consider switching to a CPU with simpler circuit requirements. The 8088 requires several external chips just to generate its clock signals and handle its input and output. By contrast, microcontrollers such as the 87C750 or COP8 put the whole computer on a single chip, including RAM, EPROM, and input-output ports. Their assembly languages are related but not identical to that of the 8088. For high-end systems, consider the Intel 80386EX, which is almost a whole PC on a chip.

If you already have an 8088 (almost) running, here are some circuits you can use. We'll start by telling you how to add ports to the bus of a PC; then we'll explain what to do if you're using a simpler 8088 circuit with different control signals.

The 8088 bus has address lines, data lines, and control lines. On the PC, the most important control lines are /IOW, /IOR, /MEMW, and /MEMR, for "I/O port write," "I/O port read," "memory write," and "memory read," respectively.

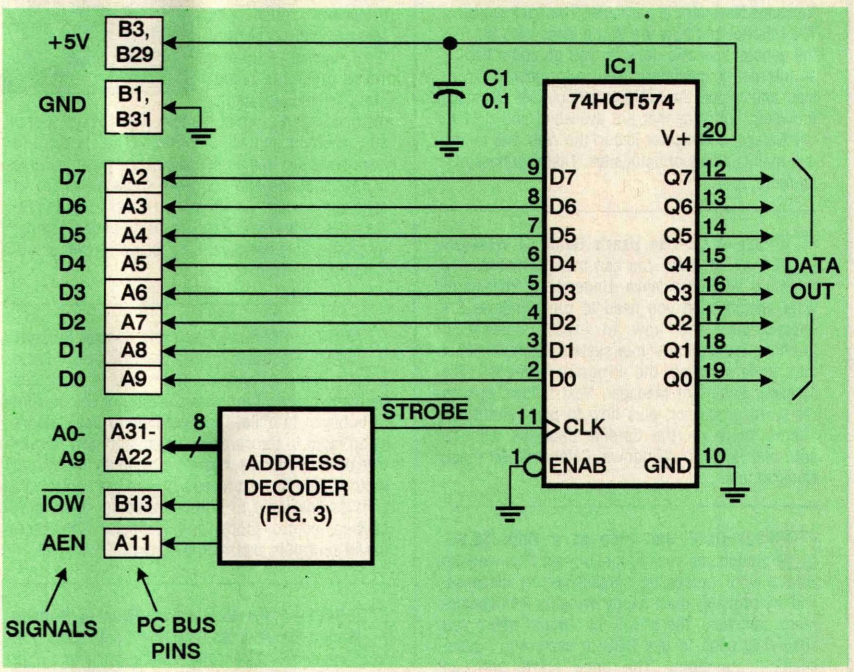

FIG. 1—HERE'S A SIMPLE 8-BIT OUTPUT PORT for a PC bus. Data sent to the appropriate hex address will appear on the output pins.

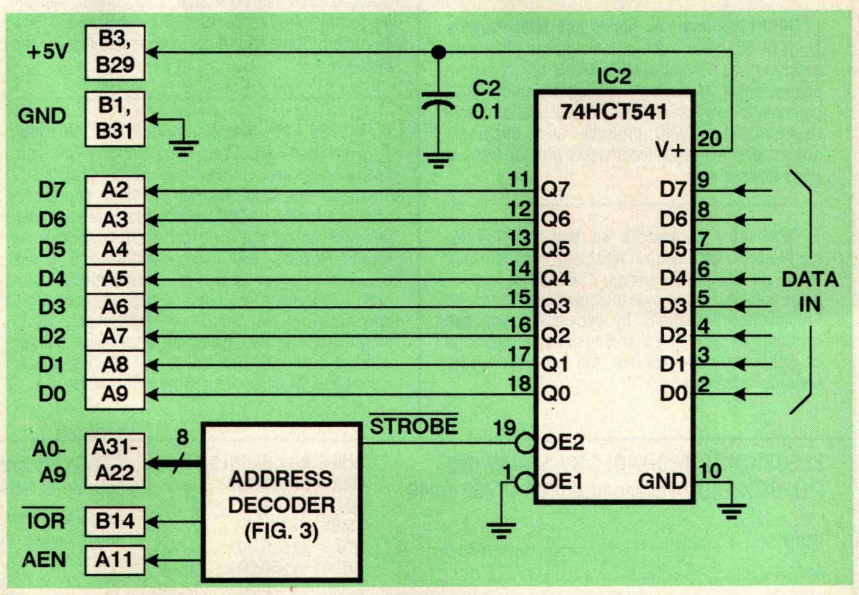

FIG. 2—THE INPUT PORT is nearly identical to the output port, but substitutes a 74HCT541 driver for the 74HCT574 of Fig. 1.

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1992 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, Box 637, Spanaway, WA 98387.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts both amateur and professional.

The slash, also written as a minus sign or a bar above the letters, indicates that these lines are "active low," *i.e.*, 0 volts signifies action and +5 volts means do nothing. Another control line, AEN ("address enable"), means "don't use the bus right now" and goes high if a device other than the CPU is using the bus to access memory.

To write to a port, the CPU puts the address on the address lines, the data on the data lines, and 0 volts on /IOW. To read from a port, it puts the address on the address lines, puts 0 volts on /IOR, and reads the signals that the port puts on the data lines. Memory access works the same way except that /MEMW and /MEMR are used instead of /IOR and /IOW.

Figures 1, 2, and 3 show how to add an I/O port to an ISA- or EISA-bus PC. You can build the circuit on a RadioShack 276-1598 printed-circuit board, which has an edge connector that plugs into a slot in a PC; you'll then have a handy board for interfacing the PC to analog-digital converters and other equipment.

The pins on the edge connector are numbered A1-A31 and B1-B31; don't confuse those numbers with the designations of address lines A0-A9 or the data lines D0-D7. The diagrams show bus pin numbers as well as signal designations.

Figure 1 shows how to build an 8-bit output port. We've assigned this one an address of hex 280, *i.e.*, binary 1010000000. The address decoder (which we'll get to in a minute) takes its output low if and only if 1010000000 is on the address bus, AEN=0, and /IOW=0. When that happens, data is latched from the data lines into the 74HCT574 output chip, which holds it until the next time you access the port. You can place data there by executing an OUT instruction to address hex 280 in assembly language or BASIC.

Figure 2 shows an input port. Here the 74HCT541 transceiver transmits data from its inputs to the bus only when the correct address is present, AEN=0, and /IOR=0. The data can be read with an IN instruction from the appropriate address. The input and output ports can have the same address because one is triggered by /IOR and the other by /IOW.

Figure 3 shows how the address is decoded. All the address decoder has to do is recognize a particular pattern of 12 bits (10 address bits plus AEN and /IOW or /IOR). One way to do that is to use a pair of 74HCT688 8-bit magnitude comparators. The 74HCT688 has two sets of 8-bit inputs, called "P" and "Q," and its output goes low when they are equal. So all you have to do is hard-wire the desired bit pattern to the "P" inputs and connect the address bits, AEN, and /IOW or /IOR to the "Q" inputs.

There are plenty of other ways to decode addresses. If you're building several ports at the same time, you might want to run the bottom 3 or 4 address bits to a '138 or '154 demultiplexer so you can decode a block of adjacent addresses with a single circuit. You may also want to decode the higher address lines, A15-A10, to distinguish a larger number of addresses.

Memory-mapped I/O works just like port I/O except that it is triggered by /MEMR or /MEMW rather than /IOR or /IOW. On the 8088, memory-mapped I/O is seldom used because it requires you to decode all 20 address

continued on page 61

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Parts Options

In reference to the article, "Negative Voltage Converter" (**Electronics Now**, January 1997), please note that other, higher current devices are available, such as the Linear Technology LT1054CN—which has a pinout that matches the ICL7660—and Power Trends 78SR105 and 78SR112 series. The LT1054CN can output 100 mA, while the SR105 outputs 1 amp and the SR112 outputs 400 mA. The 785R devices are basic positive regulators and double as negative converters by reversing the outputs of pins 2 (GND) and 3 to become negative out (2) and GND (3).

GEORGE L. KUTYBA
Beltsville, MD

PCDrill Corrections

I have received a few letters from readers pointing out an error in my article on the "PCDrill (**Electronics Now**, February 1997), which references a 5/16-inch 20-threaded rod available at most local hardware outlets. The readers correctly pointed out that the U.S. standards are 18 and 24 threads-per-inch, not 20. I actually used a 5/16-inch, 18-threaded rod in the unit shown in the photograph that accompanied the article.

When I went back and checked, I found out that the local hardware outlet carries 5/16-inch rods (no threads-per-inch specified) and 5/16-inch Coarse USS Nuts. I verified that these were, in fact, 18 threads-per-inch by using the enhanced software (specified as CD-S in the Parts List). That software uses a setup file that includes a calibration factor. The value of that factor is 864, (which I determined experimentally by allowing the table to move exactly one inch, and logging the number of steps it took to do so). Because the stepper motor traverses 48 steps in one revolution, 864 steps divided by 48 steps per revolution equals 18 revolutions. For those wishing to use other sizes and/or threads per inch, the appropriate factor can be determined by multiplying the threads per inch by 48 and changing the value in the setup file.

J.J. BARBARELLO

Antifreeze Alternative

I just read the article "Freezer Sentry" (**Electronics Now,** February 1997) and thought your readers should be told as soon as possible about a safer alternative to poisonous ethylene glycol antifreeze (the type usually used for automotive applications). Although alcohol as described in the article will work, a better alternative is to use propylene glycol, which is usually sold as RV or plumbing antifreeze. It is a completely non-toxic antifreeze, and is used as one of the additives in ice cream as well as some other food products. According to the CRC Handbook of Chemistry and Physics, the freeze point depression is almost the same for propylene glycol as for ethylene glycol. It is very dangerous to place ethylene glycol near food, or near to where a child or pet may come into contact with it—especially when such a safe alternative exists.

PAUL OOSTINDIE
Via Internet

Phone Line Monitor Suggestions

I just read "Phone-Line Monitor" by James Melton (**Electronics Now**, March 1997). It looks like a useful circuit. but I have one comment: Diode D1 is a 5.1-volt Zener and the alarm is triggered if the phone-line voltage drops below 5.1 volts. With some telephones, the off-hook line voltage drops below 5.1 volts and will trigger the alarm when that phone is off-hook! In addition, the voltage drop across the silicon diodes (D3-D6) will make the voltage at pin 5 of IC1-a less than the line voltage.

I just built a tester for telephones and phone lines (and for other line-connected equipment). While planning it, I measured the line voltages and currents of nine telephones to determine the range to be expected in normal use. The normal on-hook voltage of my home phone line is always very close to 51 volts. (My local service uses solid-state central-office equipment, installed two or three years ago by Southwestern Bell, the local supplier). Off-hook line currents of the nine phones ranged from 25.2 to 28.2 mA, with most of them very close to 27 mA. Off-hook line voltage range was 9.6 to 4.79 volts, with most of them between 6.4 and 7.3 volts. The phone with the voltage of 4.79 (and current of 28.2 mA) is a GE cordless phone, Model 2-9515A, and is about two years old. It's our most-used phone, and I don't thing there is anything wrong with it.

In any event, anyone building the Phone-Line Monitor should connect a voltmeter to their phone line(s) and measure the off-hook voltage of all phones, modems, fax machines, and the like that are used, and use a different Zener for D1 if needed, In my case, I would use a 3.9- or 4.3-volt Zener for D1.

In addition, it is not necessary to use a 5-watt Zener diode for D1 or D2. With a 10,000-ohm series resistor R2, the current through D2, even during the ring signal, is less than 2 mA, and the power less than 25 milliwatts.

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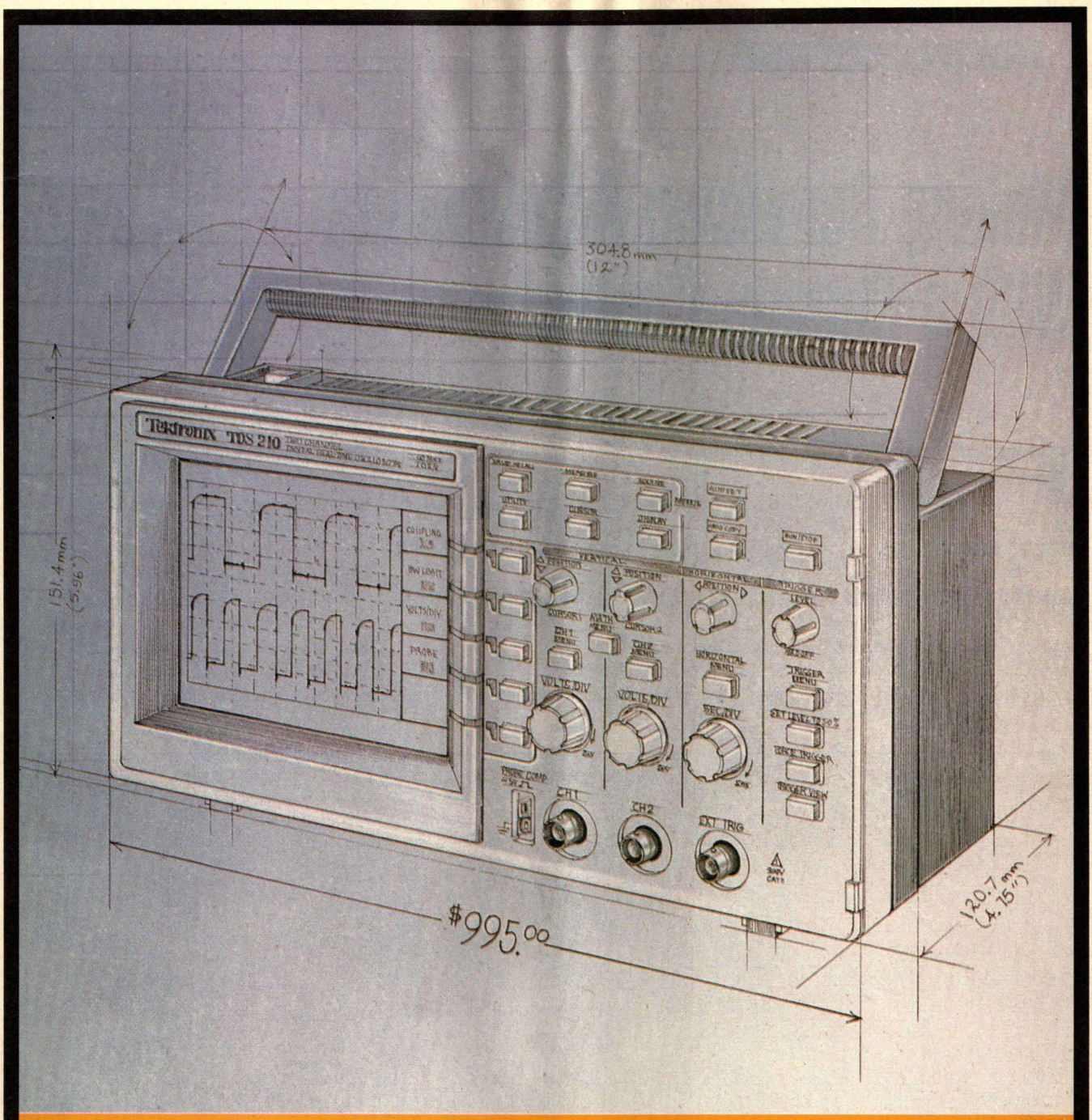

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BY HITACHI TECHNICAL SERVICES STAFF*

Making Servicing Adjustments With a Remote Control

PERFORMING ROUTINE SERVICE ADJUSTMENTS—INCLUDING VERTICAL SIZE AND CENTERING, HORIZONTAL PHASE, AND GRAY SCALE—ONCE REQUIRED THE TECHNICIAN TO ADJUST POTENTIOMETERS LOCATED INSIDE THE TELEVISION receiver. That's all changing now. For example, in some of the newest Hitachi chassis, those adjustments are now made electronically, using the TV's remote and front-panel controls. That new system offers several distinct advantages:

•Most common, secondary adjustments can be made without removing the back cover.

•Data relative to the adjustments is stored electronically, and the adjustment data is continually refreshed throughout the operational cycles of the product.

•Adjustments are stable, and less likely to drift over time.

•Eliminating potentiometers reduces chassis clutter, and increases the overall reliability of the product.

*Hitachi Home Electronics (America), Inc., 675 Old Peachtree Road, Suwanee, GA 30174

The Adjustment System

As shown in Fig. 1 the Hitachi adjustment system is composed of three major sections: the system control microcomputer (I001) that acts as the control element of the system; the EEPROM (I002), in which adjustment data is stored; and one or more "controlled" ICs. Adjustment data is written into the EEPROM during the adjustment process and memorized. During set operation, the system control microcomputer extracts that data and, through the controlled ICs, maintains all necessary adjustments at their preset levels.

Access to the adjustment system is provided by the remote control and/or front panel controls. Table 1 presents a

Table 1

Adjustment	Adjustment Code	Adjustment Data
Audio Adjustment Key Code	A 00	Entrance Key 020
Stereo VCO Adjustment	A 01	027
SAP VCO	A 02	030
Filter	A 03	026
Input Level	A 04	009
Separation (Low)	A 05	032
Separation (High)	A 06	022
Picture Adjustment Key Code	P 00	Entrance Key 030
PIF VCO	P 01	063
RF AGC	P 02	044
Horizontal Phase	P 03	019
Vertical Centering	P 04	001
Vertical Size	P 05	030
Red Background Cutoff	P 06	157
Green Background Cutoff	P 07	179
Blue Background Cutoff	P 08	132
Green Drive Gain	P 09	094
Blue Drive Gain	P 10	100
Sub-Brightness	P 11	000
Sub-Color	P 12	000
Sub-Tint	P 13	-10
Sub-Sharpness	P 14	004

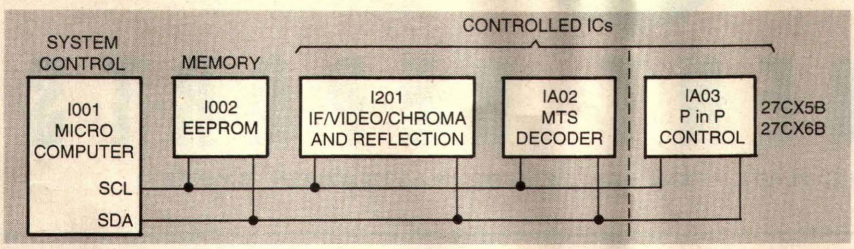


FIG. 1—HERE'S A BLOCK DIAGRAM of the entire electronic control system. It replaces conventional potentiometers and offers greater convenience and performance.

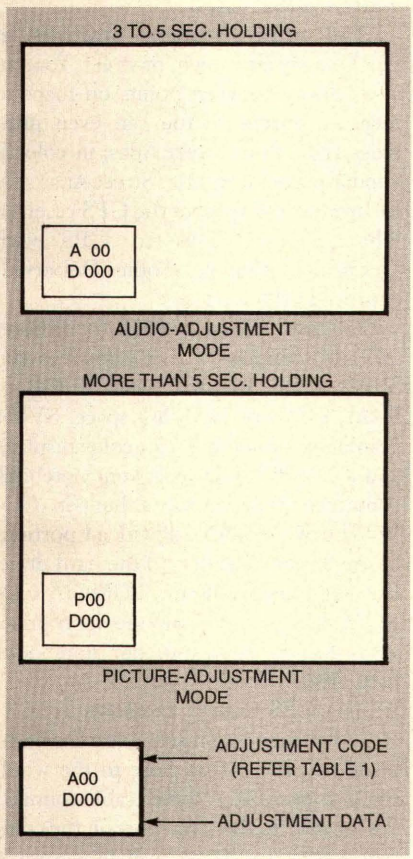


FIG. 2—THE ADJUSTMENT MODE you enter will depend on how long the MENU or AVX keys are held. Note that to prevent accidental use, the initial displays (as shown) deny the user access to the system.

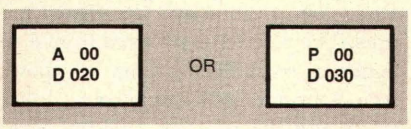


FIG. 3—TO ENTER THE ADJUSTMENT system, use the right and left arrow keys to change the display from D000 to D030 in the Picture mode, and to D020 in the Audio mode.

complete listing of all adjustments that can be made using the system. Note, however, that there could be some code variations from model to model, and that this feature is only built into specific Hitachi receivers. Those include models 20SA3B, 27CX5B, 27 CX6B and 27CX25B. All of those TVs use the M3LXU chassis.

We can only get into the adjustment modes from the front panel. Once in, actual adjustments are made using either the remote control or the front panel. To start, go to the front panel and press and hold the AVX or MENU buttons. Then press the POWER button and hold it for 3-5 seconds (to access the audio adjustment mode); or more than 5 seconds (to access the picture adjustment mode).

When the adjustment system is activated, a small box will appear in the lower left hand corner of the screen, as shown in Fig. 2. The box contains two alphanumeric codes (a letter followed by a series of numbers). The upper code indicates the type of adjustment that can be performed:

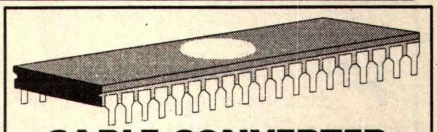
The letter A designates audio adjustments. The two numbers following denote the specific audio adjustment that can be made. The letter P designates picture adjustments. Again, the two numbers following identify the specific picture adjustment that can be made. The lower code numerals indicate the actual adjustment data that is stored in the EEPROM. The numbers will vary as adjustment proceeds.

The values shown in Fig. 2 are significant. Note in Table 1 that A00 and P00 are "key codes", and do not represent a specific adjustment mode. If the data value is also 000, access to valid adjustment modes are denied. That prevents the customer from accessing the adjustments, and protects against accidental or unintended adjustments by a service technician. Before you can start making adjustments, the data indication must be changed from D000 to D030 in the P, or Picture mode; and to D020 in the A, or Audio, mode (see Fig. 3).

That's done using the right and left arrow keys on the remote control or front panel. Once the appropriate value appears, use the up and down arrow keys on the remote control or front panel to select the adjustment mode desired, using the codes from Table 1.

Note: The up and down arrow keys can always be used to scroll from the A to P modes as long as the data value is set to 20, but cannot be used to scroll back to the audio mode once the picture mode is entered.

There you have it. How the system works, what it does, and how you can adjust it. A word to the wise. **These adjustments should only be made by a professional.** An incorrect setting could cause damage to a TV receiver's circuitry or picture tube, and that damage could be expensive to fix. If you are not sure about what you are doing, don't do it unless you are willing to take the risk. Damage caused by incorrect settings won't be covered by the set's warranty. EN



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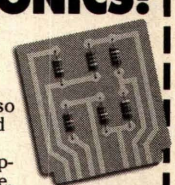

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Maps can be clumsy to handle and confusing to read at times. And they can't tell you where you are at any given moment. For that you need a Global Positioning System, or GPS, receiver. For those not familiar with it, GPS is a constellation of 24 Navstar satellites that orbit the earth in six orbital planes. At least five satellites are in "view" from anywhere in the world at any given time. If a GPS receiver can lock onto at least three of those satellites, a position fix can be maintained.

Consumer GPS receivers have been around for a while, but they've generally been very expensive, and sometimes additional maps were extra. But today that's all changed. Now you can buy DeLorme's *Tripmate Hyperformance GPS Navigation* system for only $149! That device works with notebook computers, and is as accurate as any civilian GPS receiver can be.

GPS position accuracy depends on several factors. To begin with, there are two GPS services: the Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). The general public only has access to SPS, while PPS is reserved for military and authorized personnel. The Tripmate GPS receiver is an SPS device. The chief difference between the two services is accuracy. The government intentionally provides Selective Availability (SA), which is the deliberate degradation of the satellite data, to prevent the GPS system from being used against it.

Due to SA, Tripmate's accuracy is limited to 328 feet horizontally and 512 feet vertically, 95 percent of the time. However, because you're moving, and because the system's software is always comparing GPS location to an actual map, its best guess as to where you are is usually right on target.

GPS Navigation

The Tripmate Hyperformance GPS Navigation package includes a GPS receiver that connects to the serial port of a PC, most likely a notebook PC because you'll be on the road. The receiver works with two of DeLorme's mapping programs, *Street Atlas USA 4.0* and *AAA Map'n'Go*—Street Atlas is included in the package. Street Atlas USA on CD-ROM is a fantastic program in itself. The single disc contains a map of the United States that you can zoom into and see every street in the entire United States!

The program's search functions let you find any city, town, or street. You can also "draw" between points on maps to measure distances. You can even print maps right from Street Atlas, in color if you have a color printer. Street Atlas sells for around $45 without the GPS receiver. The program links to GPS with DeLorme's Tripmate or other DeLorme-approved GPS receivers.

You need at least a 386SX/33 or faster PC and Windows 3.1 or higher to run Street Atlas. You also need 8 MB of RAM, 8 MB of hard-disk space, SVGA graphics (preferably a 256-color display), and a CD-ROM drive. If your notebook computer doesn't have a built-in CD-ROM drive, you can download portions of the Street Atlas disc to the hard drive. For our tests, we used a PCMCIA CD-ROM drive to load only the appropriate maps for our area into our notebook's hard drive.

The GPS receiver measures 3- × 5- × 1.75-inches, and it sits up on the dashboard of your car, as close to the windshield as possible. A 6-foot cable connects the receiver to the serial port on the computer. Because the receiver uses a serial port, your notebook computer doesn't need to have PCMCIA slots. The 12-channel GPS receiver constantly tracks the Navstar satellites to keep as accurate a fix as your location and the system permits. The receiver is powered from 4 AA batteries, so it doen't drain any power from your notebook computer.

To use the receiver, you run Street Atlas and select Start Tracking from the menu bar. If it's the first time you're running the GPS receiver, or if your position isn't immediately indicated by a green arrow on the map, the receiver must be initialized. This involves selecting the state or province where you are located, and making sure the port settings for the receiver are correct. Then it should take

continued on page 74

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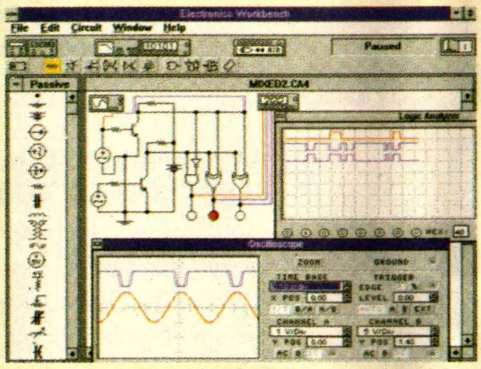

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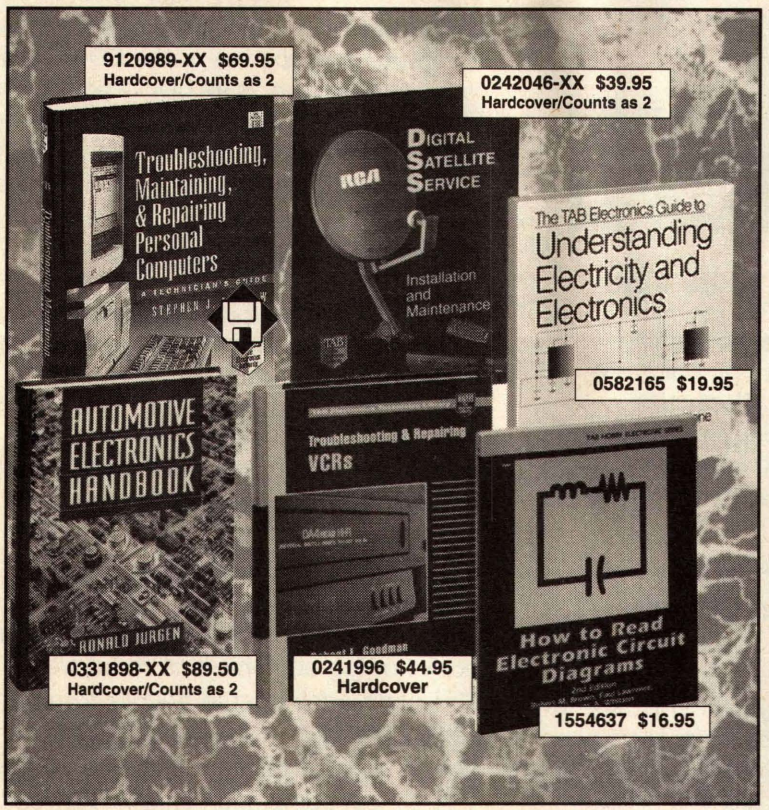

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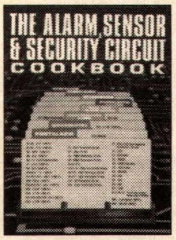

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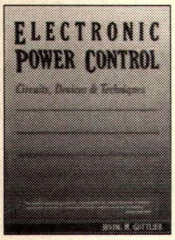

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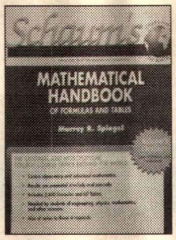

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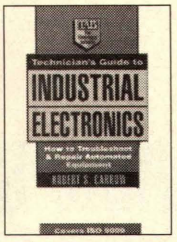

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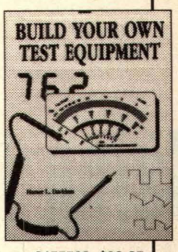

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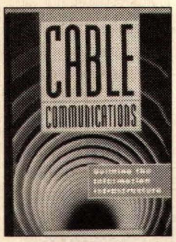

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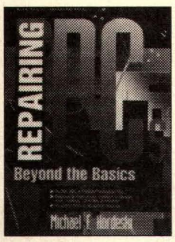

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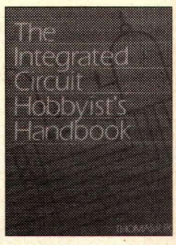

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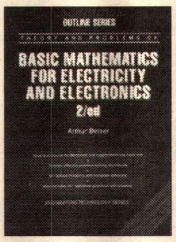

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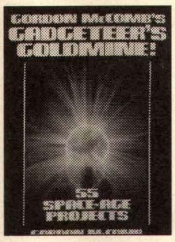

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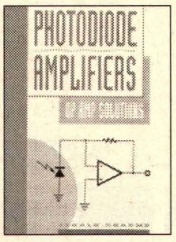

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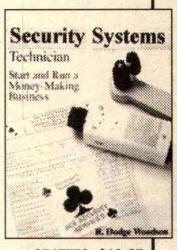

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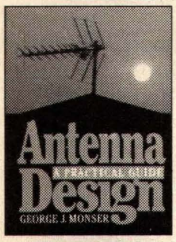

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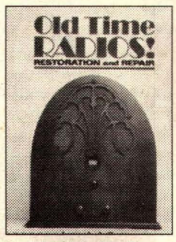

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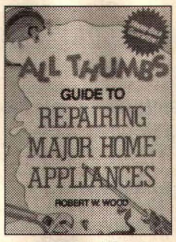

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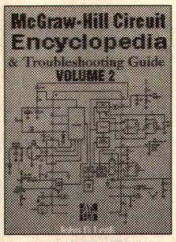

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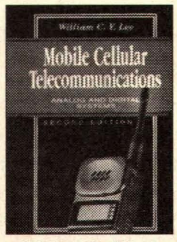

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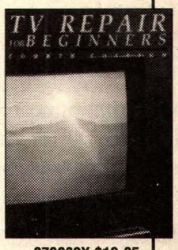

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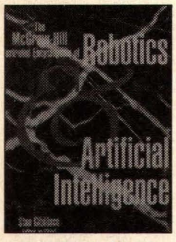

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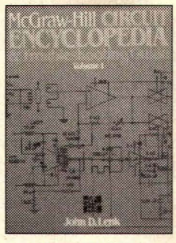

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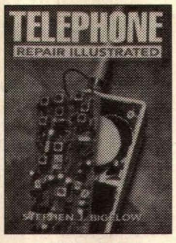

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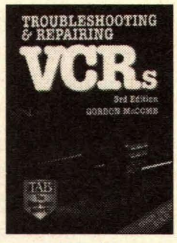

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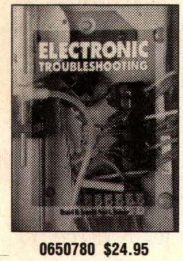

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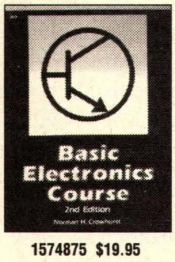

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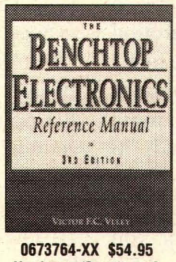

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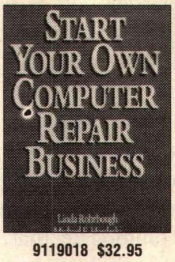

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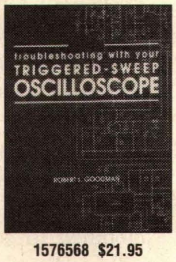

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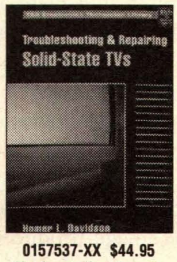

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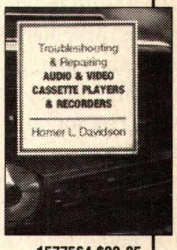

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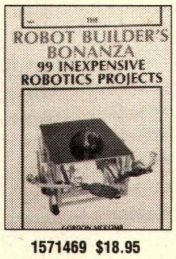

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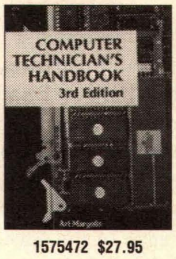

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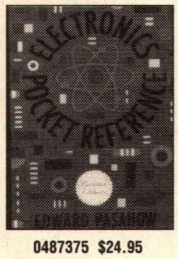

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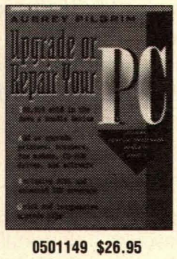

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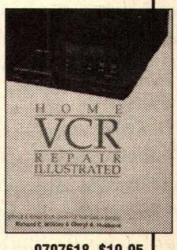

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BY CARL J. BERGQUIST

Using Lasers to Make Holograms

ONE OF THE MOST FASCINATING ASPECTS ASSOCIATED WITH LASER RESEARCH IS ITS ABILITY TO PRODUCE PHOTOGRAPHS WITH THREE DIMENSIONS. ACTUALLY, IT IS THE LASER'S PROPERTIES OF COHERENCE AND PHASE THAT MAKE THESE photographs appear to be 3-D. In a normal photo, the direction and intensity of light on any given part of the subject is recorded on the film. With the laser photo, or hologram, the distance of each part of the subject from the film is also recorded. Here's how:

Since different areas of the subject are either closer or further away from the film, the light reflected from the object strikes the film at different phases. That reflected light is known as the object beam. A second light source, or reference beam, is projected directly onto the film. Since no reflections take place, the phase of that light is uniform. By combining the two beams on the photosensitive plate or film, the mismatches in phase set up an interference pattern, which creates the three-dimensional effect.

One restriction in viewing holograms is that the viewing light must be of the same frequency as the exposure light. By using the same laser for both, that problem is eliminated. The image produced will appear in the same color as the light source. Since we are using a He-Ne laser, the image will be in red.

With theory out of the way, let's turn our attention to the equipment we will need. That includes the laser, some optics and mirrors, film and developer, and a special layout table. Once you have those, you have everything that you need to shoot, process, and display holograms. The laser and optics should be old friends by now. We'll take a careful look at the film and processing chemicals later. That leaves the assembly table.

The Assembly Table

The major enemy of good, clean, holograms is vibration. Long exposures are needed. Therefore, it is essential that the components of a holographic arrangement be kept as motionless as possible while the picture is being shot. Vibration can be caused by everything from accidentally bumping the table, to passing trucks, to even thunder. That's why the assembly table must be sturdily built and designed to dampen all unwanted movement.

The first consideration is where to place the table. Pick an area on a ground floor or basement that is part of the foundation. A garage with a solid concrete floor is a good choice. Also, keep in mind that the exposures have to be made in total darkness (except for the light from the laser); the room must be selected or modified to accommodate that, or you will need to build a light-tight hood for the table.

Once you have selected a suitable location, erect the table supports, a maximum of 24 inches high, in the appropriate spots. Obviously, that is dictated by the size of the table. Cinder-block or concrete-block legs with squares of heavy carpet on top work quite well. Situate them at each of the corners, and inset them about 3 inches from each side. If you are building a large table, place a fifth leg to support the center. If additional legs are needed for total stability, add them.

WARNING! ! !

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While the table can be a almost any size, a couple of considerations need to be kept in mind. It does need to be large enough to accommodate all the components of the assembly, and it needs to be as heavy as is practical to help smooth out vibration. Figure 1 shows a 50- by 20- by 10-inch table that will weigh in excess of 125 pounds when completed. It provides enough room for most experiments, as well as all the stability you are likely to need.

The diagram is self-explanatory, but here is a step-by-step discussion of the construction. First, the primary case, measuring 50 by 20 by 10 inches (outside dimensions), is built from ½-inch plywood. It is probably wise to place this box on the support legs at this time, as the total weight will start adding up very quickly. Next, inflate to firm, but not full, three 7- by 16-inch diameter inner tubes. Place them, side by side, in the bottom of the main case. The rubber tubes act as the primary damper for vibration. Now

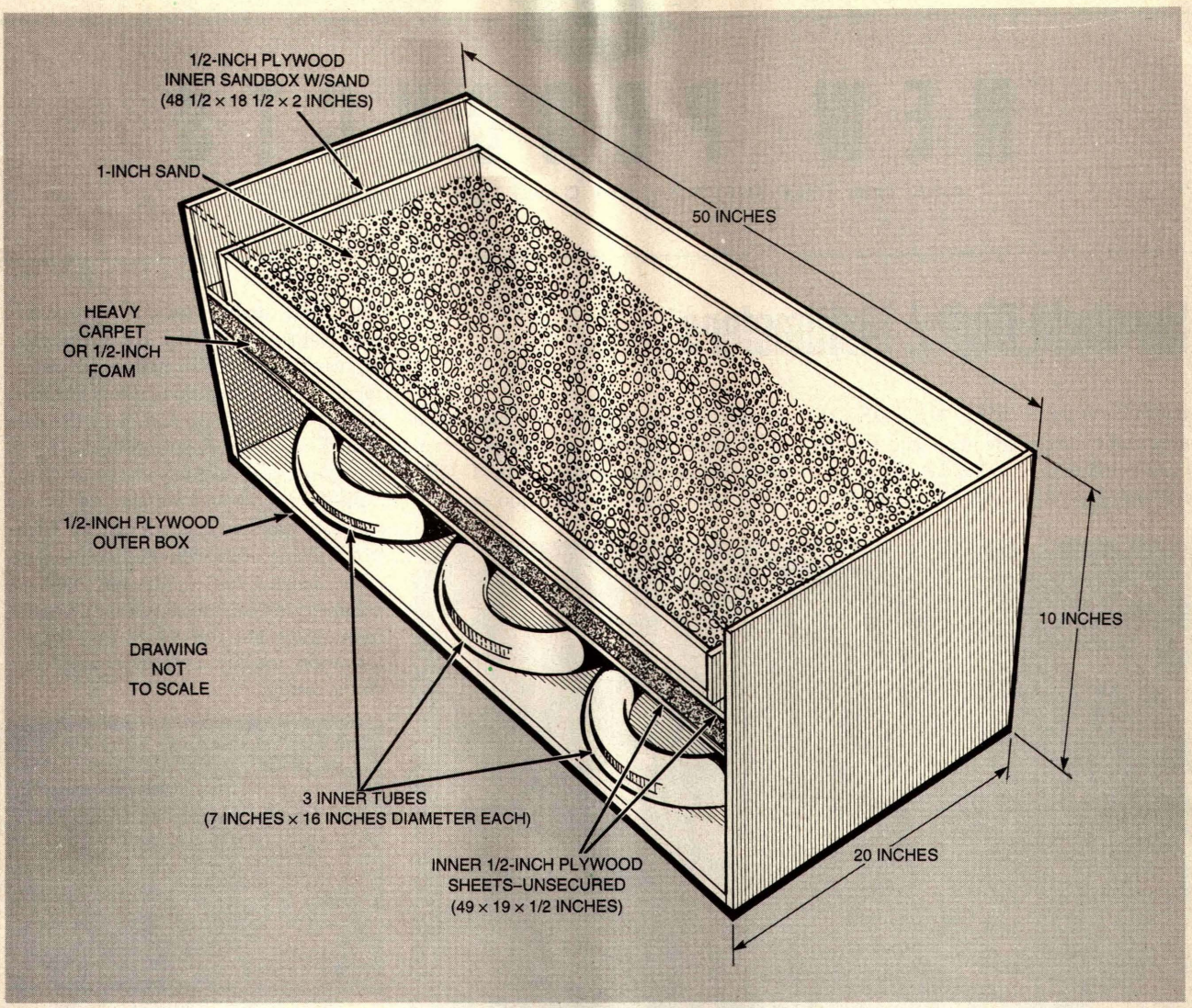

FIG. 1—A HOLOGRAPHY ASSEMBLY TABLE must be solidly built and positioned in a vibration-free area. Long exposure times are required, so no movement can be tolerated.

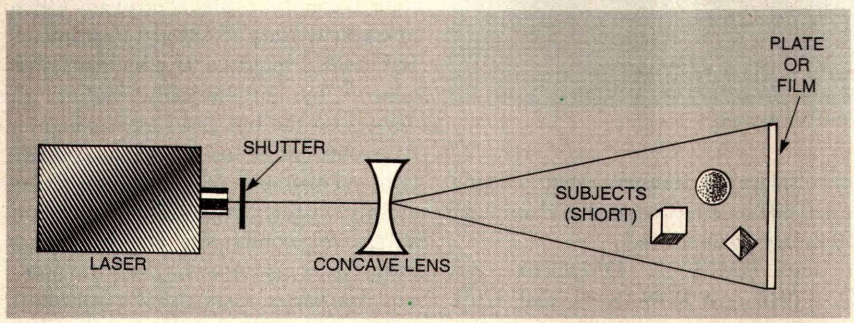

FIG. 2—USE THIS SINGLE-BEAM HOLOGRAM layout to make transmission-type holograms when shorter subjects are involved.

lay a 49- by 19-inch sheet of ½-inch plywood on top of the inner tubes. Heavy carpet or ½-inch foam rubber, also measuring 49 by 19 inches, is put in place and another ½-inch sheet of plywood goes on top of that. Both plywood sheets are cut to fit tightly, but must not bind with the inside of the main box. A second ½-inch plywood box, measuring 48½ by 18½ by 2 inches, is built and placed on top of the second "free-moving" sheet. Fill that box with sand to a depth of about 1 inch. The sand serves two purposes. It contributes about 80 pounds of weight to the table, and it provides a flexible and stable way to position the assembly components. With everything in place, smooth the sand to provide an even surface and your table is ready for action. Now, let's look at how to make the holograms themselves.

Two Types Of Holograms

Holograms come in two basic varieties, transmission and reflection. With transmission holography, the subject is placed in front of the film and a single, diffused beam acts as both the reference and object beam. With short subjects, the film can be directly behind. With taller objects, it needs to be positioned to one side. The setup for shorter objects is shown in Fig. 2; the one for taller subjects is shown in Fig. 3. Both are for single-beam transmission holograms.

The reflection method works just as the term implies, with the film or plate in front of the subject and facing away from the diffused beam, instead of into it. Here, again, a single beam acts as both object and reference. The differ-

continued on page 74

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BUILT WITH THE NEEDS OF electronic design engineers and technicians in mind, the handheld true-rms digital multimeters in Tektronix's DMM910 Series offer high resolution and accuracy and low prices. The series consists of the entry-level DMM912, the mid-range DMM914, and the high-end DMM916. All three are category III certified to 600-volts AC, and each model offers temperature testing, dual numeric display, and peak-hold capabilities. All three models also feature adjustable auto power-off, memory store/recall, a durable casing, and a three-year warranty.

CIRCLE 20 ON FREE INFORMATION CARD

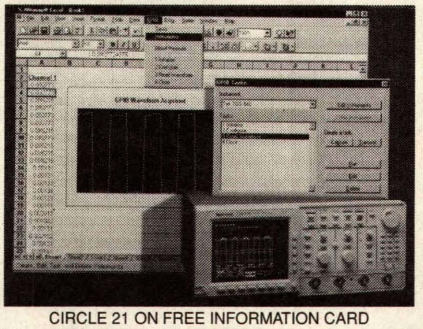
The DMM914 and DMM916 let users clearly read two measurements at once. For instance, engineers can measure amplitude and frequency of current or voltage without switching between signal displays. Those two models also can measure temperature in both Fahrenheit and Celsius, eliminating the need for separate temperature meters. The DMM-916's 1-ms peak-hold function captures and displays fast, transient events, making it possible to detect anomalies that might otherwise go unnoticed.

The DMM912, DMM914, and DMM916 cost $199, $249, and $299, respectively.

TEKTRONIX, INC.
P. O. Box 500
Beaverton, OR 97077-0001
Tel: 1-800-479-4490, action code 724
Web site: http://www.tek.com/Measurement

Spreadsheet Add-In for Excel

Version 1.1 of National Instruments' Measure spreadsheet add-in for Microsoft Excel adds GPIB instrument control capabilities and enhanced data-acquisition features. Users can configure data-acquisition and GPIB and serial instrument control operations using intuitive, pop-up dialog boxes, and place the data directly into Excel spreadsheets. From there, users can take full advantage of the built-in analysis and presentation power of Excel. Measure makes it easy for scientists and engineers who use Excel to generate analyses and reports for analytical chemistry, physiological research, process monitoring and control, design characterization, quality assurance, and electronic testing.



CIRCLE 21 ON FREE INFORMATION CARD

The Measure GPIB module can be used to connect to and control any GPIB instrument using a National Instruments IEEE 488.2 interface. It simplifies GPIB control by automatically finding all devices on the bus and by providing an interactive utility for testing the connection and operation of instruments. Users simply enter instrument command strings for configuring and measuring from GPIB instruments. With the Measure data parser, users specify a worksheet cell address to keep only the data they need. Users can combine GPIB instruments, serial instruments, and plug-in data-acquisition hardware for more flexible control and measurement operations.

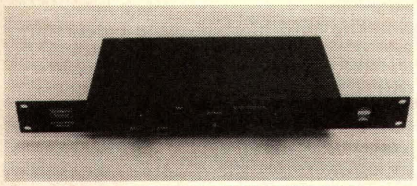
For data-acquisition users, Measure 1.1 adds enhanced timing and triggering capability for more advanced operations. For applications that scan multiple analog input channels, users can take advantage of National Instruments' *SCXI* signal-conditioning system.

Measure Version 1.1 costs $495.

NATIONAL INSTRUMENTS
6504 Bridge Point Parkway
Austin, TX 78730-5039
Tel: 1-800-433-3488
Fax: 512-794-8411
E-Mail: info@natinst.com
Web site: http://www.natinst.com

Record Noise Reducer

Aimed at audiophiles and record collectors, Esoteric Sound's Surface Noise Reducer Model SNR-1 addresses the most common problem with LP and vintage phonograph records: clicks, pops, and crackles. When connected to a standard hi-fi installation (just like an ordinary graphic equalizer), the device reduces surface pops and clicks without affecting the music. The SNR-1 has only two controls: distortion limiting and noise reduction. It also has a hard-wire bypass to remove it from the audio path.



CIRCLE 22 ON FREE INFORMATION CARD

The Surface Noise Reducer's circuitry uses digital ICs and a design algorithm capable of identifying and removing most clicks and pops on records. According to Esoteric Sound, it is 70–90% effective on LPs and 20–40% effective on most vintage records; it also reduces ignition noise from FM-radio broadcasts.

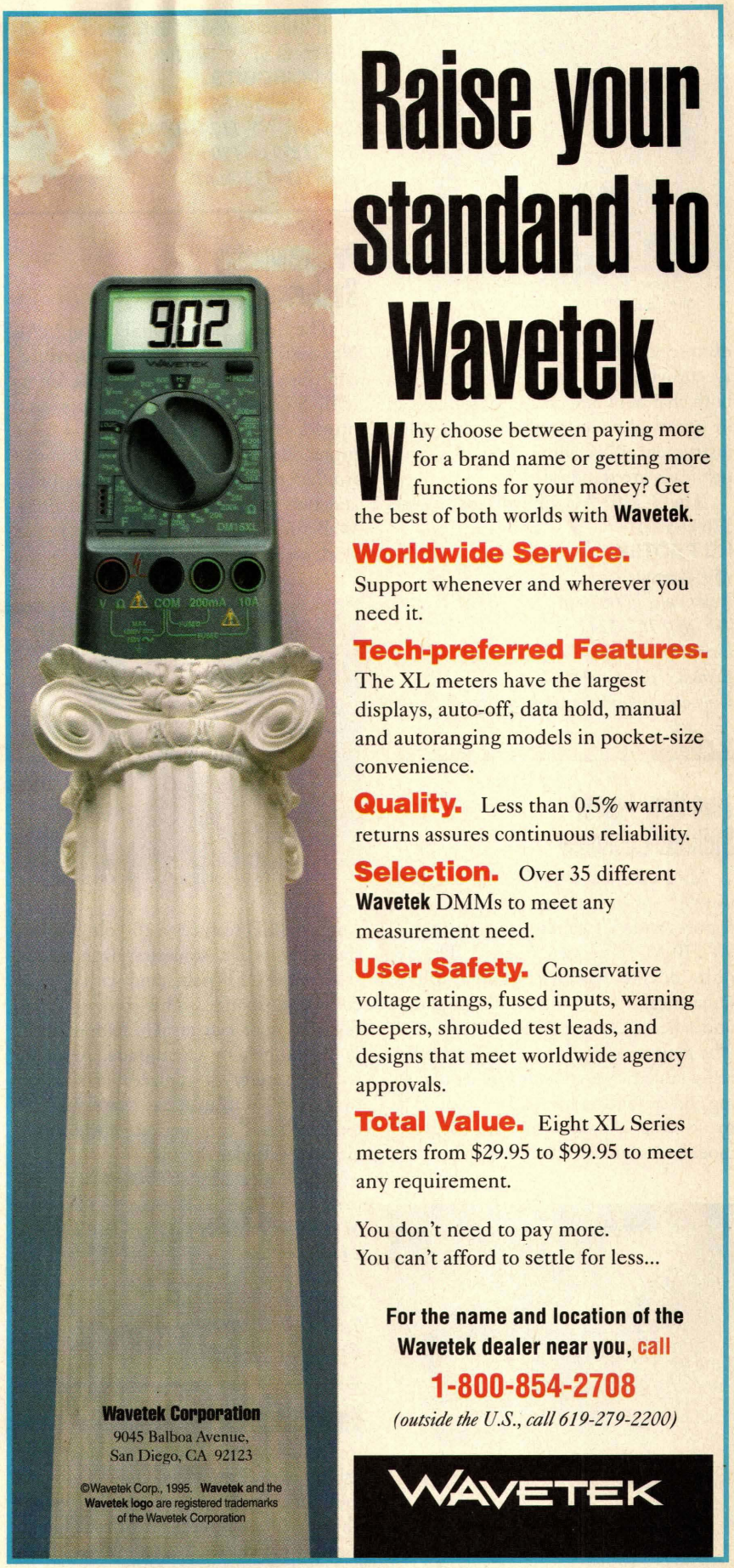
The Surface Noise Reducer SNR-1 costs $450.

ESOTERIC SOUND
4813 Wallbank Avenue
Downers Grove, IL 60515
Phone/Fax: 630-960-9137

AC Millivolt Meter

The Model B-3201 two-channel, 1-MHz bandwidth AC millivolt meter from HC Protek allows continuous and separate measurements of two different input signals via push-button control. It also enables quick, accurate readings of crosstalk and gain.

The Model B-3201 features 100-μV capabilities, and 10 Hz to 1 MHz bandwidth on both channels. It can also be used as a level meter with both dB or


Raise your standard to Wavetek.
Why choose between paying more for a brand name or getting more functions for your money? Get the best of both worlds with Wavetek.
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Support whenever and wherever you need it.
Tech-preferred Features.
The XL meters have the largest displays, auto-off, data hold, manual and autoranging models in pocket-size convenience.
Quality. Less than 0.5% warranty returns assures continuous reliability.
Selection. Over 35 different Wavetek DMMs to meet any measurement need.
User Safety. Conservative voltage ratings, fused inputs, warning beepers, shrouded test leads, and designs that meet worldwide agency approvals.
Total Value. Eight XL Series meters from $29.95 to $99.95 to meet any requirement.
You don't need to pay more.
You can't afford to settle for less...
For the name and location of the Wavetek dealer near you, call
1-800-854-2708
(outside the U.S., call 619-279-2200)
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Wavetek Corporation
9045 Balboa Avenue,
San Diego, CA 92123
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CIRCLE 23 ON FREE INFORMATION CARD

dBm scales. Rear-panel output terminals are provided for each channel so that both channel 1 and channel 2 signals can be observed on an oscilloscope or other instrument. BNC input connectors with test leads are standard.

The B-3201 AC millivolt meter costs $264.95.

HC PROTEK
154 Veterans Drive
Northvale, NJ 07646
Tel: 201-767-7242
Fax: 201-767-7343
E-mail: HC protek@aol.com
Web site: http://www.techexpo.com/WWW/hcprotek

Two-Way Power Splitter/Combiner

Mini-Circuits' PQW-2-270 is a two-way-90° power splitter/combiner that features wide 3:1 bandwidth covering the 90–270-MHz frequency range. The 50-ohm device has 1.0° typical phase unbalance, 1.4-dB maximum amplitude unbalance, and a typical VSWR of 1.25:1. The plug-in unit is housed in an hermetically sealed case and withstands operating and storage temperatures from -55°C to +100°C. Applications include I&Q modulators and QPSK modulators.

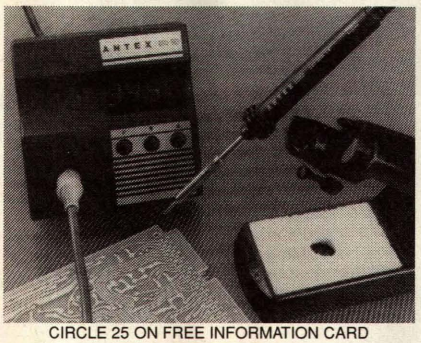
CIRCLE 24 ON FREE INFORMATION CARD

In quantities of 1 to 9, the PQW-2-270 costs $29.95 each.

MINI-CIRCUITS
P. O. Box 350166
Brooklyn, NY 11235-0003
Tel: 718-934-4500
Fax: 718-332-4661

Programmable Soldering Station

The Antex Model 690SD from M.M. Newman Corporation is a temperature-controlled soldering station that meets MIL-STD-2000A requirements and provides positive tip feedback and static protection. It offers temperature control from 65 to 450°C with 2°C repeatability and two push-button memory settings. Well-suited for assembly and repair work on sensitive electronic devices, the



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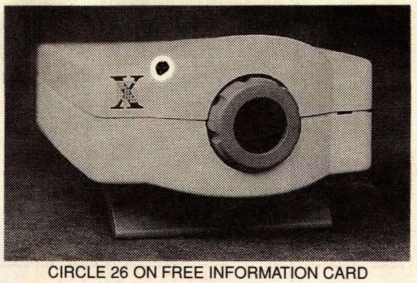
Antex 690SD features a 20-volt, 50-watt static-dissipative soldering iron and a self-contained bench stand with a dross collection sponge. The soldering station's readout can display temperatures in Fahrenheit or Centigrade. Available with a variety of replaceable slide-on tips, the 50-watt iron has a tapered handle that stays cool because the heating element is under the tip.

The Antex Model 690SD has a list price of $346.45.

M.M. NEWMAN CORPORATION
24 Tioga Way
P. O. Box 615
Marblehead, MA 01945
Tel: 617-631-7100
Fax: 617-631-8887

Videoconferencing System

Xirlink, whose Visionlink videophone brings affordable videoconferencing to the home or office, believes that videophones will become the next fax/modem for the PC industry. Visionlink consists of



CIRCLE 26 ON FREE INFORMATION CARD

a true-color, audio/video digital camera, software, and a Universal Serial Bus (USB) cable. USB provides simple plug-and-play flexibility, correctly detecting peripherals and automatically configuring them as soon as they are attached. No video capture card is needed. The Windows-compatible software compresses and stores in MPEG, H.261, H.263, TIFF, BMP, and GIF formats. The desktop camera captures digital still-image snapshots and features an adjustable lens and an embedded microphone. Internet users can add images to their communications.

The Visionlink desktop videoconferencing system costs $99.

XIRLINK, INC.
2210 O'Toole Avenue
San Jose, CA 95131
Tel: 408-324-2100
Fax: 408-324-2101
Web site: http://www.xirlink.com

Low-Cost Testers

Wavetek's new line of multimeters and multitesters—the AM8, DM7, and DM9—can be used for basic electronic and electrical troubleshooting, test, and measurement. Applications include

CIRCLE 27 ON FREE INFORMATION CARD

everyday field service or as a do-it-yourself meter around the house, workshop, boat, RV, or car. Measurement capabili-

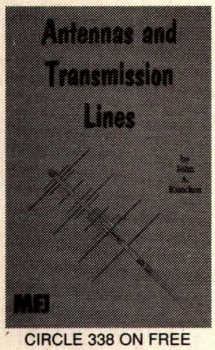
continued on page 76

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Antennas and Transmission Lines

by John A. Kueken
MFJ Publishing
P. O. Box 494
Mississippi State, MS 39762
Tel: 1-800-647-1800 or 601-323-5869
Fax: 601-323-6551
Web site: http://mfjenterprises.com
$19.95



CIRCLE 338 ON FREE INFORMATION CARD

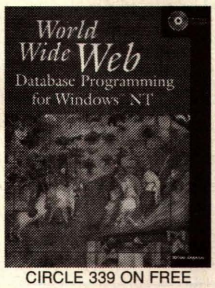
Most books that cover the theory of antennas and transmission lines fall into one of two categories—they are either graduate-level, highly mathematical texts or simplified, non-mathematical books with only simple algebra and calculus. This book represents the happy medium, providing engineers, technicians, amateur-radio operators, and students with direct, clear information.

Most of the book's 37 chapters are brief, and all are concise, making the book a handy reference source as well as a fitting text for home study. Plenty of diagrams and graphics accompany the written information. Almost all of the mathematics has been limited to no more than elementary calculus and vector algebra.

The book is divided into three sections. The first third covers basic antenna theory, including point array sources, wave interference, standing waves, collimators, lenses, apertures, and simple radiators. The next section deals with transmission lines, with discussions on topics including line impedance matching, Smith and intermittent charts, lumped circuits, waveguides, directional couplers, hybrid junctions, reactive elements, resonant circuits, and Q. The final third of the book covers selected antenna topics such as self-impedance, balance, short and anti-fade antennas, frequency- and ground-independent antennas, noise, and radio-range projection.

World Wide Web Database Programming for Windows NT

by Brian Jeppson
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 1-800-225-5945
Web site: http://www.wiley.com
$39.95, including CD-ROM



CIRCLE 339 ON FREE INFORMATION CARD

Web site databases help customers navigate through hundreds of pages of copy and several levels to find what they need, and allow companies to add new information without taking the page down. They provide customized content based upon visitor queries and give the programmer the ability to add and update content on the fly.

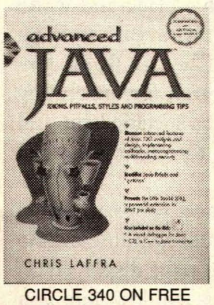
This book/software package shows you how to bring full database capabilities to your company's Windows NT Web site. It provides all the knowledge, skills, and software tools needed to configure a new or existing Web site so that visitors can access databases at the site or at other locations on your company's network. The techniques shown in the book will allow you to connect your Windows NT Web site to a wide range of databases, including those available for Windows NT, UNIX, and other database server platforms.

The book opens with an in-depth review of Internet database fundamentals, including TCP/IP, Perl scripting, ODBC (Open Database Connectivity) standard, and SQL (Structured Query Language). It goes on to provide expert advice on how to configure a Web server to support databases, use the full range of Web database publishing techniques, connect existing databases to a Web site, support searches and queries, program a database to generate HTML pages in response to user inquiries, and design and develop and original database for the Web.

The CD-ROM includes a complete Windows NT Web server, Perl and CGI scripting and programming software, ODBC extension libraries and modules for Web database access, and templates and tools for automating Web database access.

Advanced Java: Idioms, Pitfalls, Styles and Programming Tips

by Chris Laffra
Prentice-Hall PTR
One Lake Street
Upper Saddle River, NJ 07458
Fax: 201-236-7123
Web site: http://www.prenhall.com
$34.95, including disk



CIRCLE 340 ON FREE INFORMATION CARD

Aimed at sophisticated programmers who already have experience in Java, this book is a comprehensive collection of advanced Java tools and techniques that will allow them to differentiate themselves from ordinary Java programmers. It offers tips on improving Java performance and advice on avoiding Java pitfalls and inconsistencies. The book presents expert advice on a wide range of topics, including object-oriented analysis and design with Java; constructing Java debuggers; Java metaprogramming techniques, including incremental com-

pilation; implementing generic data structures; Java interprocess and interthread communications; and Java coding styles. The book helps readers identify ways to optimize Java code for faster performance, and provides well-reasoned solutions for the challenges that are often encountered by advanced Java programmers.

The book comes with a 3.5-inch diskette that includes development tools for streamlining the Java development process. It features CJ2 software for automatically translating C++ code to Java; the LKT toolkit, a powerful extension to AWT; and a new visual debugger that was developed specially for the book.

QST View: 1985–1989

The American Radio Relay League
225 Main Street
Newington, CT 06111-1494
Tel: 860-594-0200
Fax: 860-594-0259
Web site: http://www.arrl.org/
$39.95

CIRCLE 341 ON FREE INFORMATION CARD

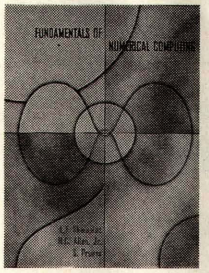
This double CD-ROM set contains a collection of back issues of *QST* magazine in a convenient, space-saving format. (A second set covering 1990 through 1994 is also available.) Each page of each issue of the magazine—including advertisements and covers as well as the articles and columns—has been scanned into a black-and-white computer image that you can read on screen or print out. The CD-ROM format allows you to search for articles by title and author, select a specific issue and year, or just browse through individual articles and columns.

The Windows-based program offers a split screen with index window on the left and the document page displayed on the right. The index window lets you know the article's title, the author's name and callsign, and when it appeared. You can also expand the document to fill the entire screen, and use your mouse to pan the image within the window.

Minimum system requirements are a 386 IBM-compatible PC (486 or better is recommended), Windows 3.1, 8 megabytes of RAM, 14 free megabytes of hard disk space, VGA graphics, and a CD-ROM drive.

Fundamentals of Numerical Computing

by L. F. Shampine, R.C. Allen, Jr and S. Pruess
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 1-800-225-5945
Web site: http://www.wiley.com
$72.95

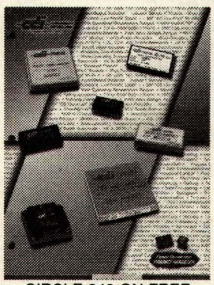


CIRCLE 342 ON FREE INFORMATION CARD

This book, intended for a one-semester course, helps readers develop an understanding of basic numerical methods for solving fundamental mathematical problems and how they are used in computing. It presents examples and exercises as well as algorithms for solving each problem. Readers are encouraged to perform hand computations as well as practice solving problems with a computer. The book also provides all needed codes, and explains precisely how they work, what they do, and what their limitations are. A basic understanding of calculus, as well as some familiarity with FORTRAN, C, C++, or MATLAB, is required.

Power Conversion Product Handbook

Conversion Devices, Inc.
5 Jonathan Drive
Brockton, MA 02401
Tel: 508-559-0880
Fax: 508-559-9288
Free

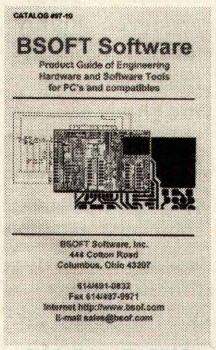

CIRCLE 343 ON FREE INFORMATION CARD

This catalog provides complete electrical and mechanical specifications on CDI's full line of more than 600 standard DC/DC converters. Its 160 pages include many new products with unique features, such as ultra-wide input ranges (4:1); miniature single in-line packaging (SIP); 8000-VPK input/output isolation; quasi-military processing; and UL, CSA, and VDE safety approvals. Single-, dual-, and triple-output converters are offered over an output range of 0.5 to 500 watts.

The catalog also offers 40 pages of application/technical notes that provide in-depth information on a range of DC/DC converter topics, including distributed power, product testing, theory of operation, thermal characteristics, typical application problems, safety agency approvals, and reliability assurance. A ten-page glossary of DC/DC converter terminology is also included.

Engineering Hardware and Software Tools Catalog #97-10

BSOFT Software, Inc.
444 Colton Road
Columbus, OH 43207
Tel: 614-491-0832
Fax: 614-497-9971
E-mail: sales@bsof.com
Web site: http://www.bsof.com
Free



CIRCLE 344 ON FREE INFORMATION CARD

This 34-page guide provides detailed information on affordable digital I/O, data-acquisition, and signal-generation products, as well as engineering schematic and PCB CAD-related software for PCs and compatibles. Featured products include the Easy-PC printed-circuit board and schematic design program, circuit-analyzer and -simulator programs, and the new PC-ScopeII PC-based oscilloscope.

Innovative Products Short Form Catalog

Global Specialties
70 Fulton Terrace
New Haven, CT 06512
Tel: 1-800-572-1028
Fax: 203-468-0060
Free

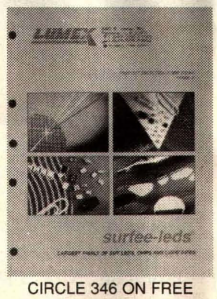
This four-page flyer features five new products and two with additional features. The new items include a unique

CIRCLE 345 ON FREE INFORMATION CARD

1-GHz spectrum analyzer scope adapter that converts any standard (5-MHz and up) oscilloscope into a spectrum analyzer; a handheld frequency counter that offers benchtop performance and features; an autoscanning true-rms power-line analyzer; a dual-variable, triple-isolated digital AC power source with power line leakage and current-measurement features; and a line of 10 surface-mount-design breadboards in two styles. The short-form catalog also includes information on logic-analysis test kits, power supplies, and other products.

Product Selection Guide 2004-4

Lumex Opto/Components Inc.
290 Hellen Road
Palatine, IL 60067
Tel: 1-800-278-5666 or 1-847-359-2790
Fax: 1-800-944-2790 or 1-847-359-8904
E-Mail: sales@lumex.com
Web site: http://www.lumex.com
Free

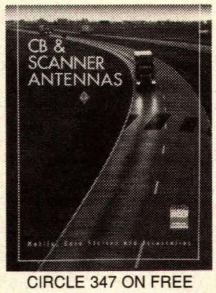


CIRCLE 346 ON FREE INFORMATION CARD

This 32-page, full-color catalog presents a large selection of styles and options in surface-mount LEDs—from chip-forms all the way to two-layered ceramic packages—all provided on reels for automatic placement. Engineering drawings are provided for each of 31 different basic product types. Full electro-optical specifications are shown in charts that are color-coded to the available LED colors. Solder heat profiles, based on extensive research into solder heat compatibility done by the manufacturer, are presented for each package style.

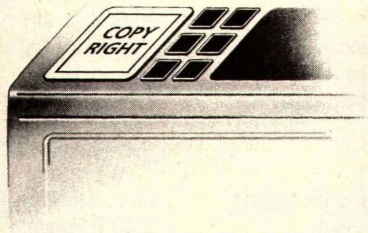
CB & Scanner Antennas Catalog (CB-1004)

Allen Telecom Group Inc.
Antenna Specialists Division
30500 Bruce Industrial Parkway
Cleveland, OH 44139-3996
Tel: 216-349-8400
Fax: 216-349-8407 or 1-800-321-9978
Free



CIRCLE 347 ON FREE INFORMATION CARD

This 14-page catalog showcases complete product lines for both mobile and base-station antennas. The mobile line offers a variety of mounting options, including "On-Glass," magnet, trunk, lid, roof, side body, and gutter. The catalog highlights the Black Stallion series, whose "On-Glass" and trunk-mount models feature a cellular-like whip antenna. Featured base-station antennas include the AV-140 Moonraker 4 dual-element and the AV-122 PDL II patented dual-polarity beam, both with very broad bandwidth. The catalog also describes Antenna Specialists' recently consolidated monitor antenna line. EN



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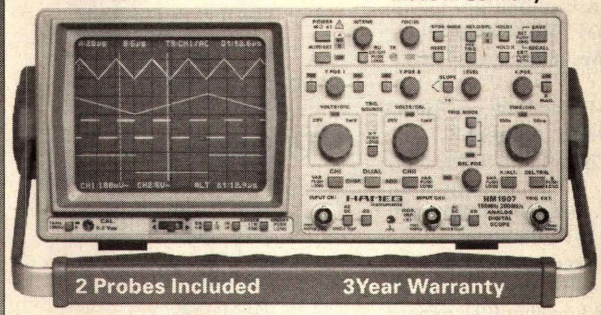
150MHz ANALOG 200MS/s DIGITAL $ 1980.00
HM1507 Made in Germany



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☑ Delay-Line ☑ 14kV-CRT
☑ Triggering: DC to 250MHz, (<0.5div.)
☑ Remote Control via RS-232 built-in Interface

Call now: Toll-free (800) 247-1241 or E-MAIL:"HAMEG@AOL.COM"

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266 East Meadow Ave. East Meadow, NY11554
(516) 794-4080 FAX (516) 794-1855
1939 Plaza Real Oceanside, CA 92056
(619) 630-4080 FAX (619) 630-6507

CIRCLE 131 ON FREE INFORMATION CARD

RETAILERS THAT SELL OUR MAGAZINE MONTHLY

Alaska

Frigid North Co.
1207 W. 36th Avenue
Anchorage, AK 99503

California

California Electronics
221 N. Johnson Ave.
El Cajon, CA 90202

Ford Electronics
8431 Commonwealth Avenue
Buena Park, CA 90621

All Electronics
14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

JK Electronics
6395 Westminster Blvd.
Westminster, CA 92683

Marvac Dow Electronics
980 S. A Street
Oxnard, CA 93030

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovif, CA 93612

Marvac Dow Electronics
265-B Reservation Road
Marina, CA 93933

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
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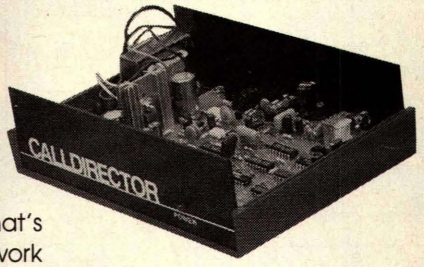

The modern telephone has come a long way since the time of A.G. Bell, especially in the last ten years or so. Deregulation of the telephone company began the loosening of an almost monopolistic grip over user equipment. That, and an almost complete replacement of the Strowger-type rotary dial with tone-dialing equipment, has resulted in an explosion of available telecommunications features and choices of inexpensive user-owned equipment. From basic handsets to sophisticated wireless phones, today's home is all but fully connected from the kitchen to the garden. In fact, with the ease of connecting equipment to the public telephone network, it's not unusual today for a typical home to have five or more telephones.

All of those phones interconnected within the average home suggests a new and interesting way of thinking about the in-home telephone system itself. Consider that not only are all of those phones connected to the outside network, but they are also connected to each other inside the home forming a kind of internal network. For many years, businesses have made use of their internal phone networks for in-house use without accessing the public network. Those setups are called Private Branch Exchanges (PBX) and they exploit the fact that businesses often have a substantial investment in their many telephones and the wiring needed to connect them. A large part of the value of a PBX is really for providing internal communication services along with the normal interface to the public network.

Using the PBX idea, it might make sense in many homes to use the in-home wiring for more than just the singular purpose of connecting the phones to the public network. Why not use the home phone system as a kind of in-home PBX by allowing it to operate as a call dispatch system and as a very practical intercom system? In most homes nearly everything is already in place. All that's needed is some kind of network management device. And that's precisely what the CallDirector described in this article is.

Consider this common scenario. Your telephone rings while you are watching television. The call is for your teenage daughter who is in her room doing schoolwork. Ordinarily, you'd get up, go to her door, tell her that the call is for her, then go back and hang up your phone. Of course, that may be good exercise, but it can become a real nuisance if she receives the seemingly endless string of calls typical of many teenagers. And don't forget the times when you're in the basement, garage, patio, or maybe you have a cordless phone in the yard and need to get someone else in the house to answer the phone.

With the CallDirector, setting up your home for that type of PBX is easy and inexpensive. You don't need to get it from the phone company. Even if you did, you'd be paying a monthly service charge that over time would begin adding up to a considerable cost, with no end in sight.

Connect the CallDirector to your home phones and in the case of your daughter's call, all you need to do is advise the caller that she is home and that you will ring her. Then on your telephone keypad, press the "#" key twice followed by whatever ring number you've given her (say "3"), and simply hang up. The CallDirector will place the caller on hold and then after you hang up will ring all house phones with her special ring which in the example would be three short rings. All phones will continue to ring until either she answers or the caller hangs up.

Another feature of the CallDirector allows you to put a caller on hold. Using the same example as before, suppose that your daughter answers the call, but then wants to leave her room and continue the conversation from another phone. She would press the "#" three times and hang up, then pick up the call on any other phone in the house. Should she become sidetracked on her way to the other phone, the CallDirector will generate a normal ring after about 80 seconds to remind you that someone is on hold. The CallDirector even has a tuner-compatible music-on-hold input that will put music on the phone line while the caller is on hold.

Still another and perhaps just as important function of the CallDirector is its ability to use any phones in the home as a full-fea-

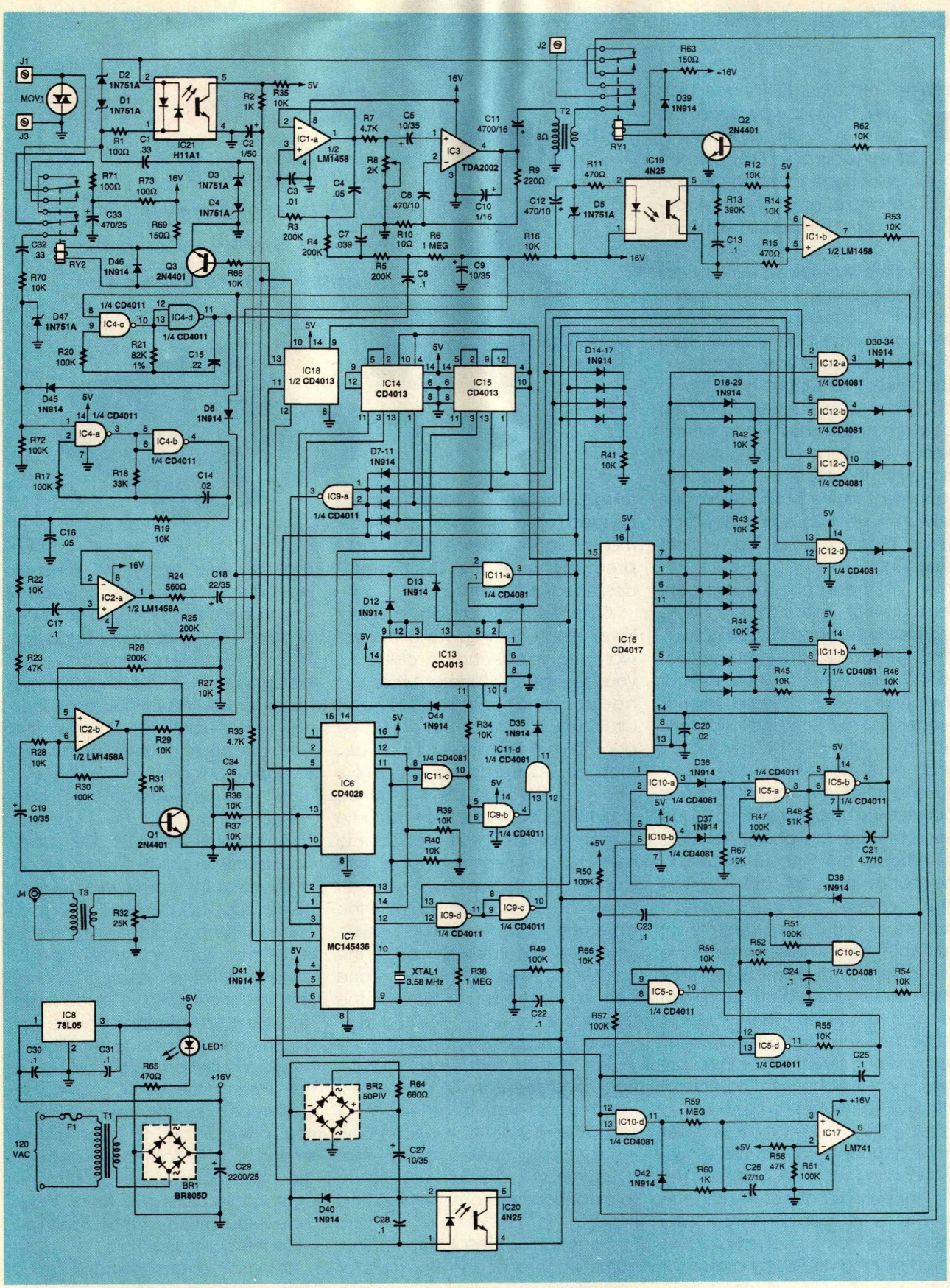

Fig. 1. The CallDirector circuit is very complex, but is also easy to use and quite reliable. Features of the CallDirector include a whole-house intercom, transferring calls to other members of the household, and placing callers on hold with music while they wait.

tured intercom. Let's say you're in the basement, garage, or yard with your cordless phone, and someone else in the home needs to contact you. They would pick up any phone, press "##9", then your particular code (perhaps "2"), then hang up. In a few seconds all phones, including yours will begin to ring with two short rings. You pick up your phone and wait a moment until the other person picks up. At this point you can hold a normal phone conversation with another extension in your home for as long as you like without an annoying dial tone. During the conversation, your outside line remains available to accept incoming calls. If an outside call comes in while you are using your home phone intercom, you will hear a low level electronic ring signal in your receiver. When that happens, one of you needs to hang up and the other simply presses the cradle button on the phone momentarily (sometimes called a "flash") to answer the incoming call.

It's that easy, foolproof, and convenient. The CallDirector unit is simple to connect. It truly does allow a completely different way of thinking about how we use our home telephones. And it significantly expands your use of what may be a substantial investment in your home telephone equipment and wiring.

How It Works. The CallDirector is a highly-sophisticated telephone-line hold control. The unit is designed to be connected to the incoming telephone line in a basement, garage, or wherever the distribution of phone lines is made in the home. Any phone connected to its output can use any CallDirector feature by simply pressing the appropriate buttons on the telephone's keypad, so any telephone connected to the CallDirector must be able to use dual-tone multi-frequency (DTMF) dialing. Two ways of putting a caller on hold along with a ringer circuit that can ring the phones with different patterns similar to the old-style "party line" telephone service are the key to the CallDirector's versatility.

The standard hold, activated by dialing "###", is used when an incoming call is to be parked as a normal hold function. If the call remains on hold for more than about 80 seconds, a normal ring is generated on all phones. The call will continue on hold until any phone on the line is picked up, even one not connected to the CallDirector, or the caller on hold hangs up.

The selective-hold function allows a call to be placed on hold but with an immediate generation of one of four easily identifiable rings. An incoming call is answered then passed to another member of the household by simply placing the call on one of the four selective holds which produces that person's specific ring. The ring pattern selected consists of from one to four short rings according to the number entered after two "#" keys. For example, entering "##4" will generate a signal of four short rings followed by a short pause. The caller on hold also hears a ringing signal while on hold.

A telephone-based home intercom function is also provided by simply lifting the handset of any phone connected to the CallDirector, entering a "##9" plus a family member's code, then hanging up and allowing one or two ring cycles to complete. By that time, the other person will have answered and a normal conversation of any length may be held. That is very useful in larger homes where telephones are placed several rooms apart, where cordless phones are used, or where there are other buildings on the property equipped with telephone extensions. In the intercom mode, the CallDirector provides full local loop simulation for operation of the in home telephone network including "local battery" for operating the phone voice circuits, 90-volt rms ring-voltage generation, and hook-status management. When using the CallDirector as an intercom, the outside line is still available for incoming calls. Should an incoming call occur, the CallDirector will gently play a low-level electronic ring signal into the conversation.

The CallDirector uses central-office quality DTMF detection through a crystal-controlled DTMF-receiver chip. That allows programmable phones to be pre-programmed so that various hold and intercom functions can be activated with a single push button on the phone.

The CallDirector also incorporates a power-fail-safe design that effectively removes it from the phone system should a power failure occur. No phone operations are affected by the presence of the CallDirector in the system unless and until its features are accessed by its specific DTMF input.

Theory of Operation. The schematic diagram for the CallDirector in Fig. 1 should be referred to during this discussion. The circuit is somewhat complicated, but can be easily divided into several sections. It will also be helpful to refer to the timing diagrams that show the logic levels at key circuit locations during either a standard hold (Fig. 2) or a selective hold (Fig. 3).

The incoming telephone-company line is connected to J1 and J3. The house wiring is connected to J2 and J3. Terminals J1 and J2 are normally connected together by RY2, D1, D2, and RY1. If there is a power failure, the normally-closed contacts of RY1 keep the house phones connected to the telephone service. Whenever a telephone is taken off the hook, loop current flows through R1 and the LED in IC21, which puts out a logic-low signal at pin 5. That signal removes the reset from IC18 pin 10 and IC13 pins 10 and 4. That enables the recognition of DTMF tones for only the "#" and "9" buttons. A low-pass filter, R2 and C2, prevents the momentary loop-current drop occurring during the make-after-break action of RY1 when transferring to a hold condition from resetting IC13 and releasing the hold. The choice of compo-

nent for IC21 makes the circuit insensitive to phone-line polarity.

The CallDirector and any other equipment on the phone line is protected from any transient voltages exceeding about 184 volts by MOV1. That protection is usually included in all telephone-line equipment such as telephones and answering machines. But when a caller is on hold, the CallDirector is the only device on the line, making

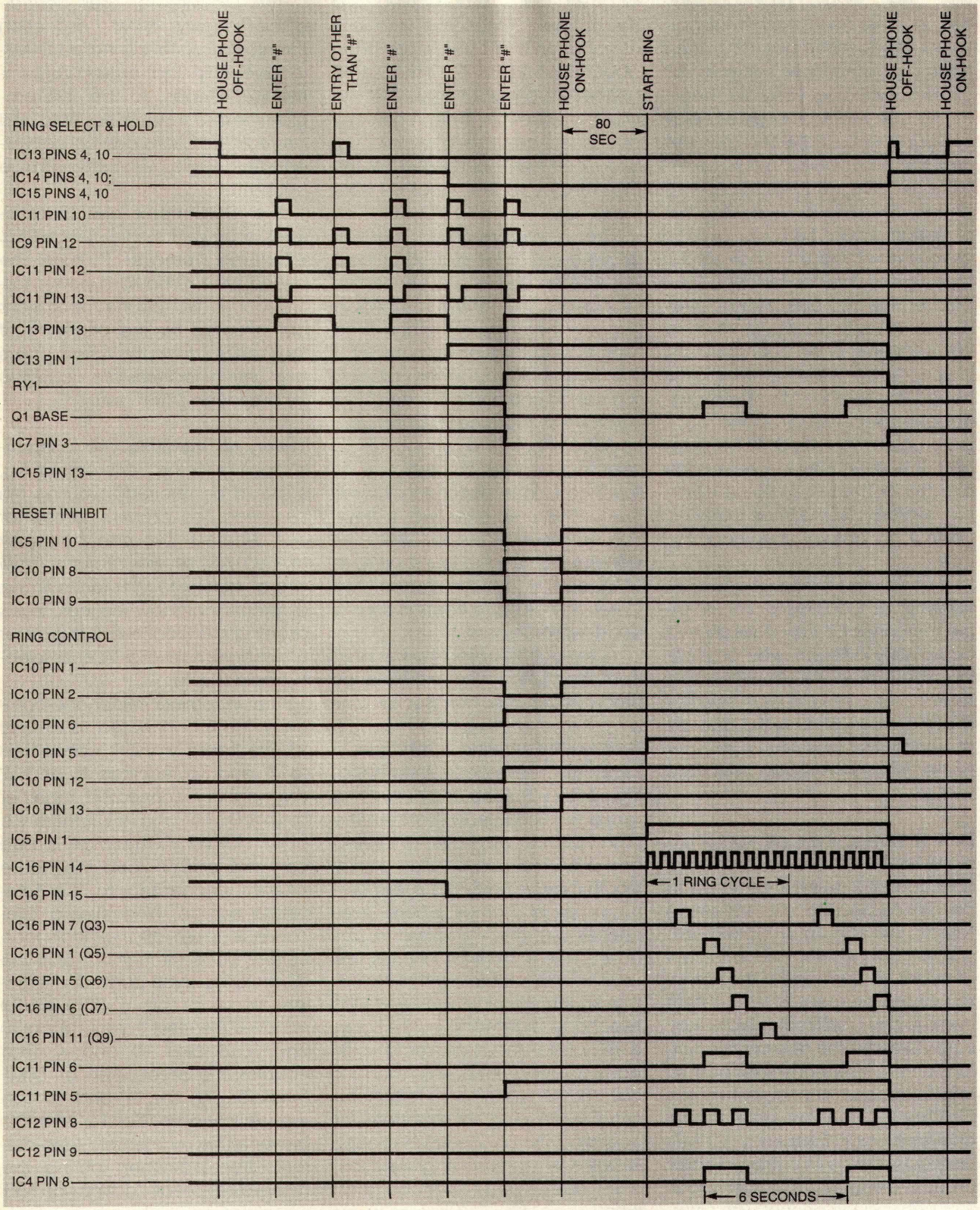

Fig. 2. This timing diagram shows how the CallDirector handles an outside call on hold. If a phone is not picked up in about 80 seconds, the CallDirector will start ringing the phones as a reminder that someone is on hold.

such protection for the CallDirector itself essential.

The CallDirector sends ring signals and music back to the outside phone line through C1. Those signals are amplified by IC2-a before being sent to the phone line. Capacitor C1 also brings tones from the house line to the analog input of DTMF receiver IC7. The input of IC7 is buffered by R33 to help protect IC7 from telephone-line transients. A small amount of equalization to improve balance between high and low tones (sometimes called "twist") is provided by C34. Phone-line voltages passing through R33 are clamped to ±5 volts by D3 and D4.

The house telephones are normally connected directly to the incoming phone line through the normally-closed contacts of RY1 and RY2. When a caller is put on hold, RY1 transfers the house phones to the secondary of ringer transformer T2 and the IC19/IC1-b off-hook detection circuit.

If any house telephone is picked up while a caller is on hold, a DC-current path is created from the 16-volt source at pin 1 of IC19, its LED, current-limiting resistor R11, the secondary winding of T2, and returning to ground through the low resistance of the off-hook telephone. The isolated output of IC19 is grounded, switching on IC1-b. Voltage divider R53 and R54 reduce the 16-volt output of IC1-b to about 8 volts for interfacing with CMOS logic circuitry.

That 8-volt level is greater than the supply voltage of the logic chips. Normally, that condition would damage the chips. However, all inputs to those chips are clamped internally with diodes so that any input voltages above the supply voltage or below ground will not destroy the ICs, as long as current-limiting resistors are put in series with any inputs where the voltages could exceed the IC's safe level. Resistors R51 and R66 are used for that purpose.

Operation of the off-hook detector while the 90-volt 25-Hz ring voltage is being generated is similar to that described above. In order to prevent the ring signal from triggering IC19, D5 prevents any reverse voltages of the ring signal from appearing across the LED in IC19. For the other portions of the ring signal, C12 bypasses most current around the LED up to the 5-volt breakdown level of D5. For protection, D5 places an absolute and unconditional limit on the current applied to IC19.

Some pulsing of the output of IC19 will occur. That is reduced by the low-pass filter combination of R13 and C13. The resulting DC level at IC1 pin 6 remains well above the comparator reference voltage on pin 5 developed by R14 and R15. However, when a house phone is picked up and a DC path is created, the resulting DC current component causes IC19 pin 5 to go solidly low, operating the comparator as discussed earlier.

Call-Holding Setup Logic. The CallDirector can receive DTMF tones at all times, but no recognition is made until at least one telephone connected to terminal 2 is off-hook. That causes the reset signal on IC18 and IC13 to go low. DTMF tones are decoded by DTMF receiver IC7 and converted to a binary-coded decimal (BCD) output. The data valid output on IC7 (pin 12) goes high whenever a valid DTMF tone pair is being decoded. Reception of the "#" DTMF tones produces a logic high on IC7 pins 13 and 14, and consequently on pin 10 of IC11-c. That signal clocks IC13 pin 11 and latches the first flip-flop, capturing the first "#"-tone input.

While the "#" tone is being received, pin 12 of IC7 goes high as does pin 12 of IC9. Meanwhile, pin 13 of IC9 is held high by pin 13 of IC13, which is the inverted output of the second flip-flop. The output at pin 11 of IC9 goes low, and through IC9-c places a high on pin 12 of IC11. When a "#" is being received, pin 10 of IC11 is high and pin 4 of IC9 is low, as is pin 13 of IC11. Under those conditions, pin 11 of IC11, which feeds into the reset line for IC13, does not go high. If, however, a DTMF entry other than "#" were to be received, the data valid signal passing through to IC11-d would not be blocked and would then appear as a reset at the reset lines for IC13.

The very same action occurs upon receipt of a second "#" input except that the first flip-flop in IC13 now clocks off, and in so doing clocks the second flip-flop of IC13 on. If some entry other than a second "#" is made, IC11-d would not block the data-valid signal. That signal would reset the first flip-flop, effectively canceling the entire sequence. That is necessary to assure that only two consecutive "#" inputs will initiate the CallDirector for the eventual third input which will establish the desired hold option.

When the second half of IC13 latches, its inverted output (pin 2) goes low, disabling IC9-d. That allows the full range of DTMF inputs to be received and decoded without resetting IC13. At the same time, the normally-high reset for selective-hold flip-flops IC14 and IC15 is enabled, allowing recognition of DTMF buttons 1 through 4. The non-inverted output of IC13 (pin 1) goes high, placing a logic high on the data input of intercom, activating IC18 pin 9, which will cause that flip-flop to latch if the next digit input is a 9. The only DTMF input recognized under those conditions will now be 1 through 4, 9, and "#". Finally, the reset on ring cadence counter IC16 pin 15 is removed in preparation for generating a ring.

Standard Hold. When a third "#" is received, indicating a standard hold, the first flip-flop in IC13 is clocked for the third time causing it to latch once again. Both flip-flops in IC13 are now latched, which means both of their non-inverting outputs are high. Several things occur when that condition is reached. First, both inputs to IC11-a go high so its output (pin 3) is also high. That enables ring-cadence-selection gate IC11-b for a normal ring when the 80-second ringer-start delay timer activates the ring clock. It also enables normal ring-

enable gate IC10-b (pin 6) so that when the timer interval ends, the ring clock will begin producing gating pulses for ring generation.

Note also that IC9-a has both inputs high through D11. The output for that gate (pin 3) goes low, totally disabling the DTMF receiver, IC7, by way of its enable pin (pin 3). Any

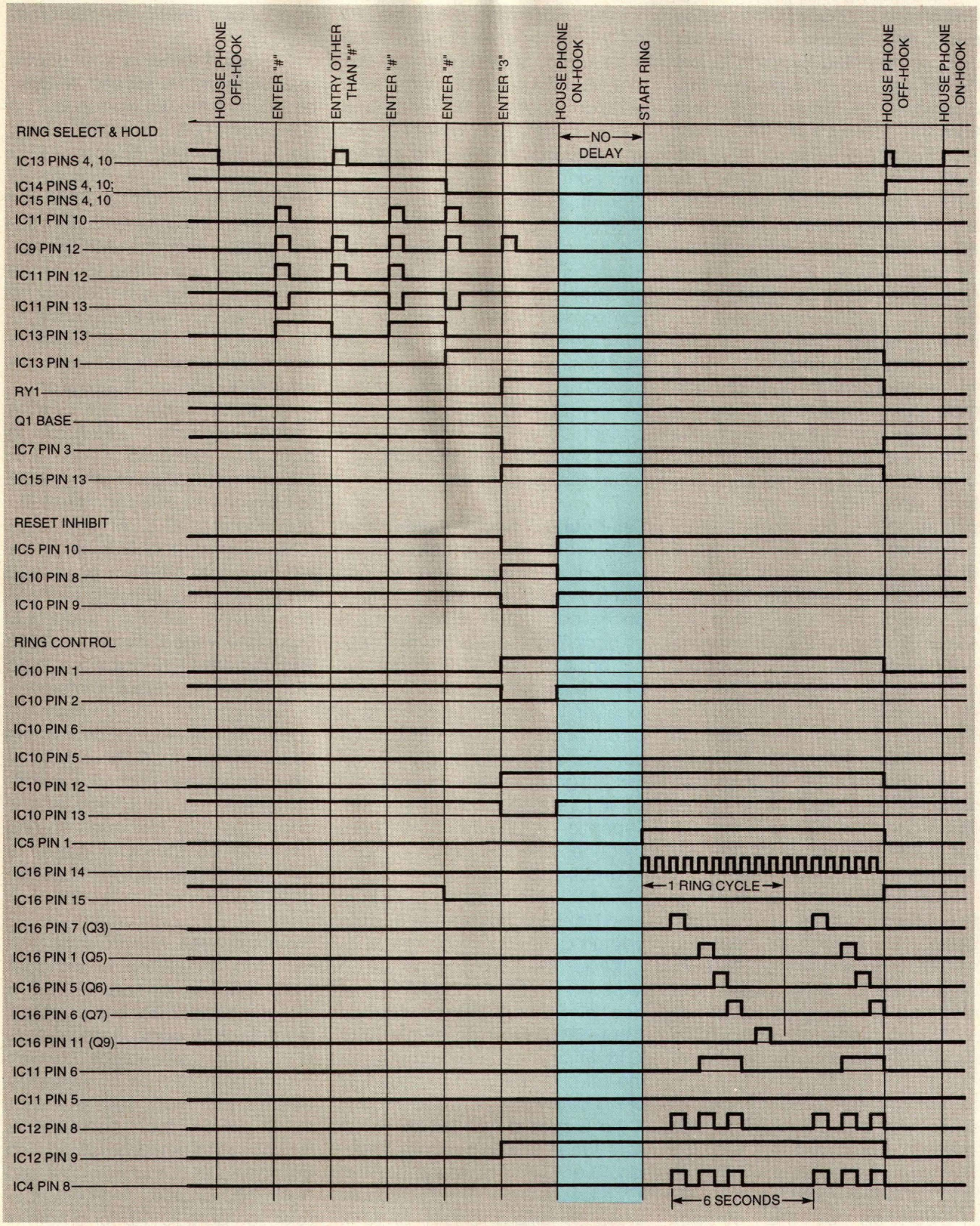

Fig. 3. The selective hold feature of the CallDirector is similar to the standard hold, but the phones are rung immediately with a pattern of 1 to 4 rings depending on which family member is to be alerted that the call is for them.

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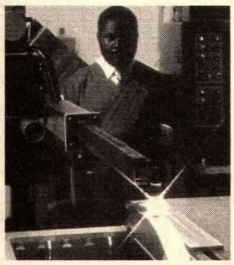

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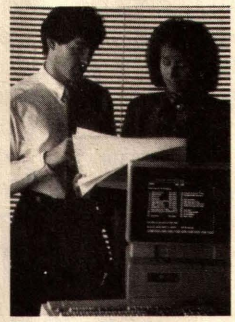

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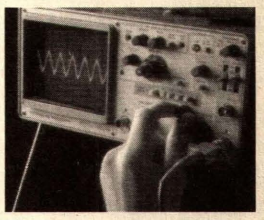

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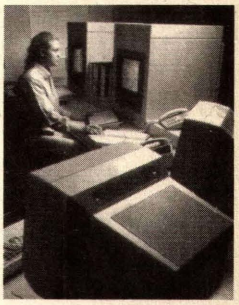

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logic high appearing at the inputs to IC9-a also turns on Q2, which turns RY1 on. When RY1 switches, the incoming telephone line is transferred to line-hold load resistor R64. Meanwhile, the house phones are connected to the output of ringer transformer T2 and the IC19/IC1-b off-hook detection circuitry.

When the outside telephone line is on hold, both inverting outputs of IC13 (pins 2 and 12) are low. That interrupts current through D12, D13, and R31, which turns Q1 off. With Q1 off, audio from the music-on-hold input amplifier IC2-b is delivered to line driver IC2-a for placement on the outside phone line. Note that Q1 is also turned on through D6 during periods when a ring signal is actually being generated. That momentarily quiets the music-on-hold during the ring-back interval, resulting in a clear ring signal to the caller on hold.

A caller is placed directly on standard hold as soon as the third successive "#" is entered. However, the ringer start delay timer does not begin the approximate 80-second countdown until the house phone that placed the caller on hold is actually placed back on the hook, which raises the reset inhibit (IC10 pin 13) high.

Reset Inhibit. The reset-inhibit circuit keeps an off-hook house phone from initiating a reset just after it has put an outside caller on hold and has been transferred to the off-hook detector IC19/IC1-b with RY1. Once the house phone is placed on-hook, the reset inhibit allows the very next off-hook condition to produce a reset. It also activates the ring circuitry immediately after the house phone goes on-hook following a selective (1-4) hold activation. In the case of a standard hold, however, the start of an actual ring is delayed by about 80 seconds through the ringer-start delay circuit.

Operation of the reset inhibit circuit centers on the latching circuit of IC5-c and IC5-d. Normally, pin 8 of IC5 is held high through R66, R50 and the 5-volt supply source, while pin 9 is low through R56, R55, and the logic-low output of IC5-d (pin 11). The output of IC5-c is therefore at logic high as is pin 13 of IC10, pin 9 of IC10 (through R52), and the special ring-enable gate IC10-a pin 2. Note that the normal ring-enable gate IC10-b is operated from IC5-c pin 10 also, but through the ringer-start delay circuit.

When any hold is invoked, IC10-d pin 12 goes high, and a momentary high coupled by C25 appears at IC5-c pin 9 through current-limiting resistor R56. That causes IC5-c pin 10 to go low and IC5-d pin 11 to go high, creating a latch condition where pin 10 now remains low. A low on IC5-c pin 10 disables IC10-c a few milliseconds before the off-hook house phone being transferred to the off-hook detector causes a logic high to appear on pin 8 of IC10. For the time being, that blocks the resetting of the IC13 flip-flops from occurring because a house phone is off-hook from a hold condition. Note also that both ring-enable gates, IC10-a and IC10-b, are now disabled so that even if a ring should be selected, it would not begin until the house phone is placed back on-hook.

When the house phone is placed back on-hook after initiating a hold, the output of off-hook detector IC1-b drops to near zero, resulting in a logic low appearing on IC10-c pin 8 through resistor R51. That logic low transition is coupled by C23 as a momentary low to IC5-c pin 8 through current-limiting resistor R66. A momentary low on pin 8 releases the latch, causing IC5-c pin 10 to go to and remain high. That re-enables IC10-c so that the very next time a house phone goes off-hook, a logic high will appear on IC10-c pin 10 creating a reset through D38. At the same time, the special ring-enable gate, IC10-a, is enabled so that if a special ring is selected, it will begin immediately. Pin 13 of IC10 also goes high, and since pin 12 is already high, pin 11 goes high initiating the 80-second time interval.

Ringer-Start Delay. The ringer-start delay consists of an enabling gate (IC10-d) and IC17, which is wired as a comparator and whose output will remain at near zero volts until the voltage on its pin 3 exceeds the reference voltage on pin 2 set by R58 and R61. When IC10-d pin 11 goes high, C26 begins charging through R59. In about 80 seconds, the voltage across C26 will reach 3.4 volts, which is the comparator reference, and pin 6 will then switch to about 16 volts. That is coupled by current-limiting resistor R57 as a logic high to normal ring-enable gate IC10-b pin 5. If a standard hold was initially set by the hold mode flip-flops, the normal ring will have been selected and will now begin.

When an on-hold call is picked up by any house phone, the reset generated releases all flip-flops. Any action or condition set by the latched flip-flops is discontinued-including the return of IC10-d pin 12 (and therefore pin 11) to logic low, quickly discharging C26 through R60 and D42. Other results of resetting the flip-flops include re-enabling the DTMF decoder; releasing RY1 through Q1, which transfers the house phones back to the incoming-phone line; disabling the cadence-selection gate; resetting ring-cadence counter IC16; removing music-on-hold audio from the input of line-driver IC2-a if the standard hold was selected; and re-enabling IC9-d so that "#" DTMF tones are the only recognized inputs.

Selective Hold. If the third DTMF input is any number between 1 and 4 instead of 9 or "#", the binary-coded-decimal output from IC7 delivered to binary-to-decimal converter IC6 will cause one of IC6 pins 14, 2, 15, or 1 to go high. That will set one of the flip-flops in either IC14 or IC15 corresponding to that number. At that time, only the second # flip-flop in IC13 is latched along with one of the number-input flip-flops (IC14 or IC15).

A logic high on any of the IC14 or IC15 flip-flop non-inverting outputs will disable the DTMF decoder through one of diodes D7-D10 and

IC9-a. The same logic high will also enable special ring-enable gate IC10-a pin 1 through one of diodes D14-D17. Note that operation of Q2 and RY1 and the reset-inhibit function is the same as for a standard hold except that when IC5-c and IC5-d unlatch, there is no delay in activating the ringer. When IC5-c pin 10 goes high, IC10-a pin 2 receives a logic high and the ring sequencing begins immediately.

Ringer. The ringer circuitry is designed to generate a ring having a specific cadence depending on which one of five logic levels goes (and remains) high. The ringer output develops a 25-Hz, 90-volt-rms sine wave capable of reliably ringing house telephones with a total ringer equivalence number (REN) of 5.0.

Every telephone or line-connected device that can detect a ring signal will have its REN clearly labeled somewhere on the device. The total of all of the individual REN values is a measure of the ring load on a particular phone line. The design of the CallDirector matches the telephone company's standard of a maximum REN of 5.0 on any telephone line.

The CallDirector ringer begins with the ring clock, consisting of IC5-a and IC5-b. That oscillator generates pulses at a rate of one positive logic transition every 600 milliseconds. The ring clock sets the basic rate of all ring cadences produced by the ringer. The ring clock operates only when either IC10-a or IC10-b places a logic high through D36 or D37 on pin 1 of IC5. Output from the ring clock (IC5-b pin 4) drives the clock input of decade counter IC16. That counter sequentially places a logic high on one of its ten outputs, incrementing whenever a low-to-high logic transition occurs at its clock input.

The reset on pin 15 of IC16 is removed when the CallDirector receives a second "#" input. When a ring is selected and the ring clock is enabled, IC16 begins counting through its ten outputs fully completing a count sequence every 6 seconds, which is the standard ring cycle for telephone systems in the US. Each high level on the output pins of IC16 remains for 600 milliseconds before moving on to the next pin. Those outputs, of which only five are needed to develop all the rings needed by the CallDirector, are coupled in various ways by a straight connection and by steering diodes D18-D29 to create five different patterns of logic highs and lows. Those patterns, repeating every 6 seconds, correspond to the five different ring types needed for the standard and selective hold features of the CallDirector as previously described.

The five different logic patterns are delivered to ring-select gates IC12-a, IC12-b, IC12-c, IC12-d, and IC11-b. Depending on the desired ring cadence, only one of those five gates will be enabled by the latched flip-flop corresponding to the chosen hold condition. The resulting selection will produce a logic high/low pattern corresponding to the desired ring and will appear on ring-frequency oscillator IC4-c pin 8. Whenever IC4-c pin 8 is high, IC4-c and IC4-d will generate a 25-Hz squarewave. That signal is delivered through D45 to the ring-back oscillator and through capacitive coupling to active-low-pass filter IC1-a.

The ring-back oscillator generates a 600-Hz signal that is gated at a 25-Hz rate. That signal, filtered by R19 and C16 to soften the typically sharp sound of a squarewave, is then capacitively coupled by C17 to phone-line driver IC2-a. Telephone users have been conditioned over time to expect a ring back as an indication that a remote telephone is ringing. That is an important feature, as it prevents a caller from believing that the call may have been disconnected. The CallDirector generates that ring back for all ring conditions.

The 25-Hz signal is also coupled through C8 to operational amplifier IC1-a, which is set up as a third-order (18-dB/octave) active-low-pass filter. Bias needed to operate IC1-a from a single-ended power supply comes from voltage divider R16/R27, filtered by C9, and delivered to the positive input through R6 and filter resistors R5, R4, and R3. The 25-Hz output waveform from IC1-a pin 1 is almost a sinewave. Voltage divider R7 and ring-adjustment resistor R8 set the signal input level to IC3 for a ringer output of 90 volts RMS.

Using the LM383 ring-power amplifier (IC3) is a straight forward use of the device directly from the manufacturer's data sheet. The gain is reduced slightly through selection of R9 and R10 to ease the one-time startup adjustment of R8. The LM383 was chosen because of its ability to deliver high currents. That is an important consideration when working with both the inductive characteristics of T2 and a load whose impedance can vary. It also features an easy-to-use TO-220 package with the heat sinking tab at ground potential.

Transformer T2 is simply a 10-watt 70-volt line transformer used typically for connecting loudspeakers to paging-type public-address systems that have long speaker-cable runs. That type of transformer is readily available, inexpensive, and has the needed steel in its core to handle the 25-Hz ring frequency at the required amplitude levels. It is used in reverse with the 8-ohm winding considered the primary and the 0.625-watt tap the high-voltage secondary.

Music on Hold. The music-on-hold input, J4, is fully isolated from the CallDirector circuitry by T3. That is important because the CallDirector circuit is directly connected to the telephone line, and the music source, typically a tuner, cannot be guaranteed to be completely isolated from the AC power line. In the interest of safety, it is best to isolate any chance of accidental connection between the power lines and the phone line.

The music level for the phone line is adjusted by R32. The gain of IC2-b is set by R28 and R30 to about 10. Both IC2-a and IC2-b are powered from the single-ended 16-volt power

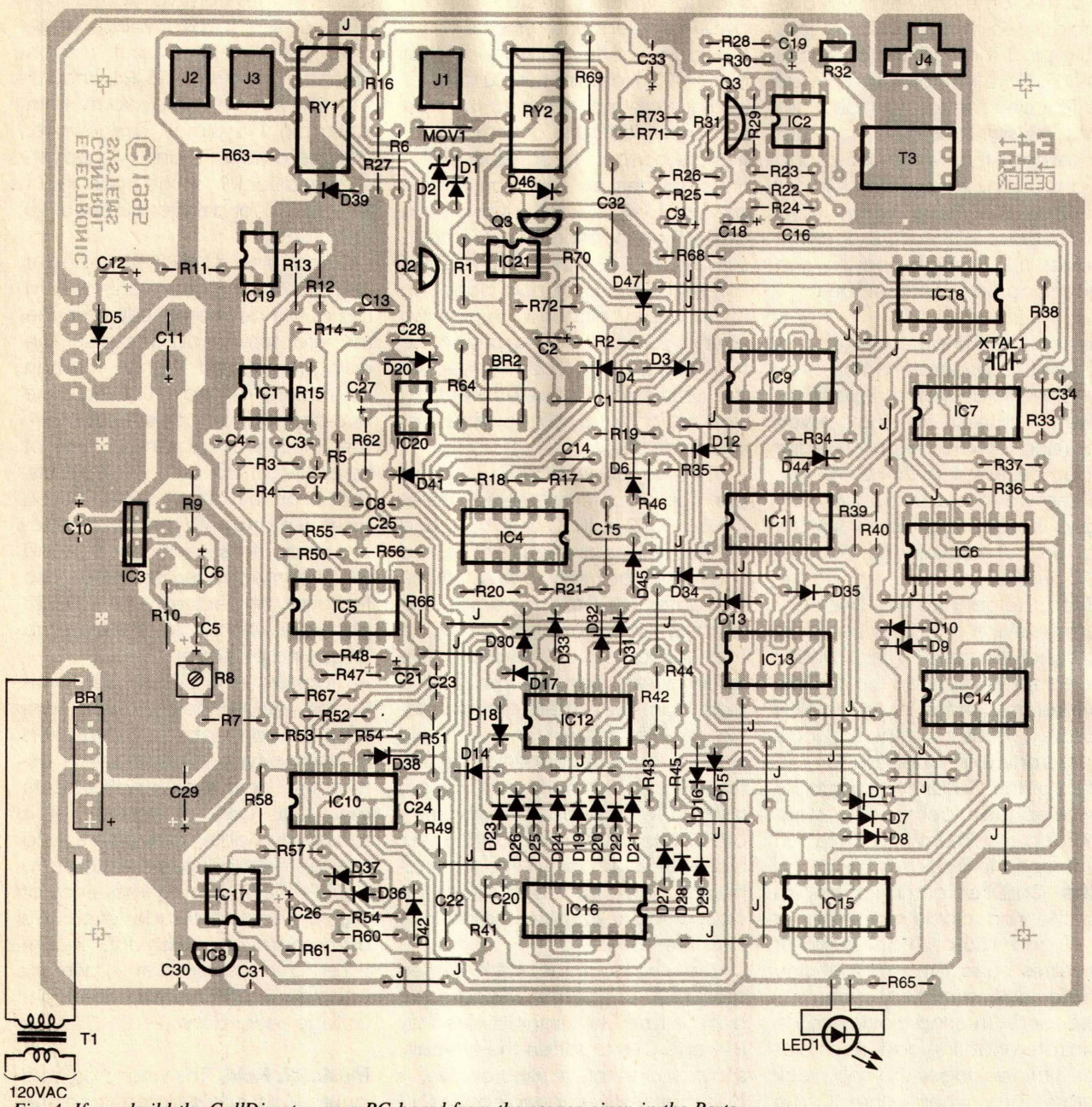
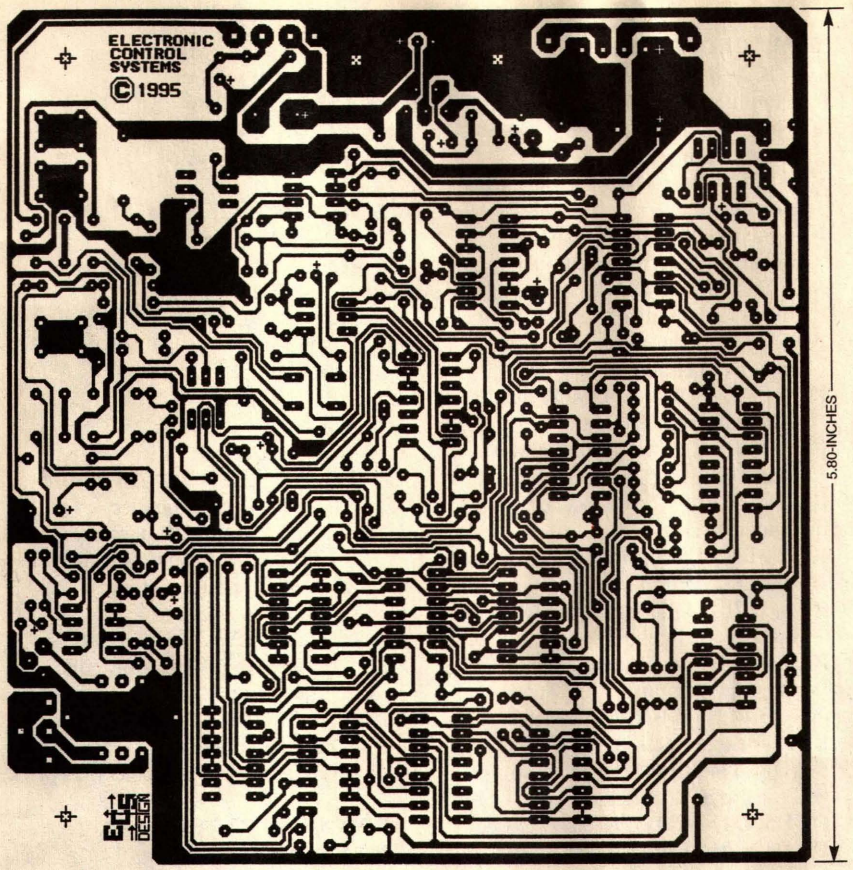


Fig. 4. If you build the CallDirector on a PC board from the source given in the Parts List or etch your own from the supplied pattern, use this parts-placement diagram to locate the various components. You might wish to mount LED1 on the CallDirector's enclosure.

supply source by biasing their noninverting inputs through R25 and R26 respectively to one-half of the power-supply voltage. Sufficient gain and level control are provided to accommodate line audio from a tuner, compact-disc player, or even the headphone output of an inexpensive portable radio.

The music-on-hold input and the audio path are both available to the phone line all the time. To prevent the music-on-hold audio from appearing on the phone line at times other than when a caller is placed on hold, Q1 is turned on, bypassing the audio signal from IC2-b to ground. When both flip-flops of IC13 are set and their inverting outputs are low, indicating a standard hold, current through D12, D13, and R31 is interrupted turning off Q1.

As soon as the standard hold time exceeds about 80 seconds, the CallDirector generates a normal ring on all house phones along with an audio ring back as discussed earlier. The logic high levels from the ring-select gates that enable the ring-frequency oscillator also appear through D6 at R31 turning on Q1 during the ring interval. That disables music-on-hold only when the actual ring back is taking place.



Here is the foil pattern for the CallDirector. Thanks to the use of many jumper wires, the CallDirector's entire circuit fits onto one single-sided board.

Loop Current-Change Detector. When a call is placed on hold, RY1 transfers the telephone line to the AC inputs of BR2, which allows the polarity-sensitive circuitry of the loop-current change detector to operate even if the incoming phone-line polarity is reversed. According to telephone-line standards, the green wire is the positive side of the 48-volt DC local-loop battery at the central office; the red wire is the return. But those colors are sometimes accidentally reversed in the house wiring.

The loop-current change detector generates a momentary reset whenever the CallDirector has a hold in progress and the phone-line loop current decreases. That feature allows the CallDirector to release the hold if another telephone on the local loop that is not connected to the output of the CallDirector is picked up. If the CallDirector is placed at the central phone-distribution point and all house phones are connected to its output, the loop-current change detect circuitry is not needed. It is included as a user-friendly feature to give the CallDirector additional versatility if not being used to operate all phones.

When the actual transfer to hold takes place, central-office loop current flows through R64 and D40 to charge C27. Since the charging current forward biases D40, C28 and the LED in IC20 are effectively not in the circuit. If the loop current decreases after having been established, C27 will partially discharge as the voltage across R64 decreases. The discharge current will flow in a direction opposite the charge current, reverse biasing D40 and momentarily forward biasing the LED in IC20. When the phototransistor in IC20 turns on, a logic high will occur on the reset line releasing all flip-flops.

Using the Intercom. Operation of the CallDirector intercom is in nearly all respects the same as when in the selective hold except for one fundamental and important difference. If just after the second of two "#" entries is made a 9 is entered, RY2 transfers the outside telephone line to an on-hook state. The central-office battery to the house phones is then replaced by a power source within the CallDirector. That substitute battery is actually the CallDirector's 16-volt source filtered by R73 and C33, then given an impedance to audio signals of about 100-ohms by R71. That arrangement allows enough talk current for the local in home "loop" to operate two or three telephones.

At the same time, C32, current-limiting resistor R70, and voltage-limiting Zener diode D47 couple any ring signals that may come in while the intercom is being used to the ring-back oscillator (IC4-a and IC4-b). With each incoming ring-voltage pulse, the 600-Hz oscillator is turned on, producing a low-level ring signal which is then injected into the CallDirector's home loop by line driver IC2-a.

Relay RY2 is turned on by Q3, which is controlled by flip-flop IC18. Like all other flip-flops in the CallDirector, IC18 is a "D"-type flip-flop, which means it transfers the logic state of its data input to its outputs whenever the clock input changes from logic low to logic high. The non-inverting output is always at a logic state opposite that of the inverting output. The reset input, when momentarily clocked high, will return the non-inverting output to its normal logic low condition.

The clock input of IC18 is operated directly from the decoded "9" output of IC6. Whenever a DTMF "9" is received by the enabled DTMF receiver IC7, a momentary logic high will appear at IC18 pin 11. However, a number of conditions must exist before the flip-flop will actually latch. First, the reset on IC18 (pin 10) is removed whenever a house phone is off-hook. Next, the "D" input is logic low until the second "#" DTMF latches the second half of IC13, placing its pin 1 high. That normally-low condition on the

input of IC18 prevents the flip-flop from changing its outputs until the entry of a second "#" because its clock would simply continue to transfer the logic low through to its output, which is already in a logic low condition.

After the second "#" is received, the input of IC18 goes high. If a 9 were to then be received, IC18 would transfer and hold that high on its output (pin 13). That would turn on Q3 through R68, operating RY2. At that point, the CallDirector can initiate a special ring and hold as described earlier. Note that when the CallDirector goes into the hold mode in order to ring the phones with the desired ring, the reset on IC18 stays off because IC21 continues to detect an off-hook condition. When any phone is then picked up, the CallDirector resets all of the hold logic, but the off-hook phone keeps IC18 from resetting, which keeps the local talk "battery" supplying current to the in-house phones. When the last of the phones is placed back on-hook, IC18 is reset and the intercom feature is released.

Note that when the intercom is activated, the standard hold is blocked by preventing any attempt at entering a third "#" from latching IC13 pin 13. That occurs when IC18 latches and its inverting output (pin 12) goes low, and through D44 holds IC13 pin 11 low, effectively disabling its clock input. Note also that pin 12, which is normally high, provides operating voltage for the loop-current change detector IC20. When the intercom is active, that voltage is removed, disabling the loop-current change detector. That function is unnecessary in the intercom mode and by deactivating it as soon as the intercom feature is started, a possible CallDirector reset is prevented when the loop current changes by transferring the RY2 contacts, or by any electrical disturbance on the public network side of the CallDirector.

PARTS LIST FOR THE CALLDIRECTOR

SEMICONDUCTORS

IC1, IC2—LM1458A dual operational amplifier, integrated circuit
IC3—TDA2002 or LM383 power amplifier, integrated circuit
IC4, IC5, IC9—CD4011 CMOS quad nand gate, integrated circuit
IC6—CD4028 CMOS binary-to-decimal converter, integrated circuit
IC7—MC145436 DTMF receiver, integrated circuit
IC8—78L05 voltage regulator, integrated circuit
IC10–IC12—CD4081 CMOS quad and gate, integrated circuit
IC13–IC15, IC18—CD4013 CMOS dual D flip-flop, integrated circuit
IC16—CD4017 CMOS decade counter, integrated circuit
IC17—LM741A operational amplifier, integrated circuit
IC19, IC20—4N25 opto-coupler, integrated circuit
IC21—H11A1 opto-coupler, integrated circuit
Q1–Q3—2N4401 NPN transistor
BR1—Bridge Rectifier, 50-volt, 2-amp (Digi-key BR805D-ND or similar)
BR2—Bridge Rectifier, 50-volt, 1-amp
D1-D5, D47—1N751A, Zener diode
D6-D42, D44-D46—1N914 silicon diode
D43—not used
LED1—Light-emitting diode, red

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
R1, R71, R73—100-ohm
R2, R60—1,000-ohm
R3–R5, R25, R26—200,000-ohm
R6, R38, R59—1-megohm
R7, R33—4,700-ohm
R8—2,000-ohm, trimmer potentiometer
R9—220-ohm
R10—10-ohm
R11, R15, R65—470-ohm
R12, R14, R16, R19, R22, R27–R29, R31, R34–R37, R39–R46, R52–R56, R62, R66–R68, R70—10,000-ohm
R13—390,000-ohm
R17, R20, R30, R47, R49–R51, R57, R61, R72—100,000-ohm
R18—33,000-ohm
R21—82,000-ohm, 1%, metal-film
R23, R58—47,000-ohm
R24—560-ohm
R32—25,000-ohm, trimmer potentiometer
R48—51,000-ohm
R63, R69—150-ohm, ½-watt
R64—680-ohm, ½-watt

CAPACITORS

C1, C32—0.33-µF, polyester
C2—1.0-µF, 50-WVDC, electrolytic
C3—0.01-µF, ceramic-disc
C4, C16, C34—0.05-µF, ceramic disc
C5, C9, C19, C27—10-µF, 35-WVDC, electrolytic
C6, C12—470-µF, 10-WVDC, electrolytic
C7—0.039-µF, ceramic disc
C8, C13, C17, C22–C25, C28, C30, C31—0.1-µF, ceramic disc
C10—1.0-µF, 16-WVDC, tantalum
C11—4700-µF, 16-WVDC, electrolytic
C14, C20—0.02-µF, ceramic disc
C15—0.22-µF, polyester
C18—22-µF, 35-WVDC, electrolytic
C21—4.7-µF, 10-WVDC, non-polar ized electrolytic
C26—47-µF, 10-WVDC, electrolytic
C29—2200-µF, 25-WVDC, electrolytic
C33—470-µF, 25-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

J1–J3—screw terminal, PC-mount
J4—RCA jack, PC-mount
MOV1—Metal-oxide varistor, 130 volts, 11 joules
RY1, RY2—double-pole, double-throw, 12-volt relay
T1—12-volt, 900-milliamp, power transformer
T2—70-volt, 10-watt, line transformer
T3—10,000-ohm/10,000-ohm, 200 milliamp, coupling transformer
XTAL1—3.58-MHz crystal, HC-18 case
Heatsink, wire, printed-circuit board, enclosure, hardware, etc.

Note: The following items are available from: Electronic Control Systems, RD2, Box 3308, Wernersville, PA 19565: Complete kit of all parts, printed-circuit board, and enclosure, $144.00; Printed-circuit board only, $22.00. Please add $6.00 for kit or $3.00 for PC board shipping/handling. PA residents should add 6% sales tax.

CallDirector Construction. Construction of the CallDirector is straight forward using standard assembly techniques. Use of an etched and drilled PC board is recommended as it greatly reduces the chance of wiring error in what is a fairly complicated circuit. Another benefit of a PC board is a very compact unit. If you decide to etch your own board from the pattern provided here or purchase one from the source given in the Parts List, follow the parts-placement diagram in Fig. 4. That board design is single-sided for easy etching and

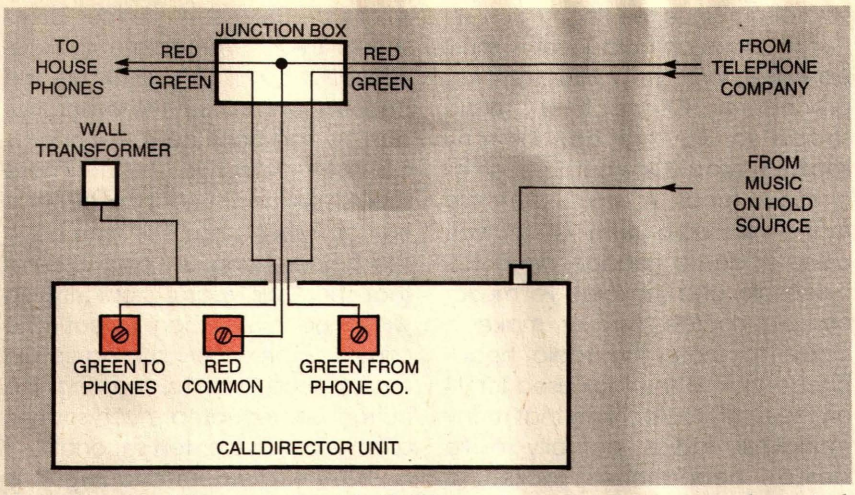


Fig. 5. Because of the complexity of the CallDirector's circuitry, it is very simple to attach it to the telephone wiring. Only one wire needs to be cut and both ends connected to the CallDirector. The other wire only needs to be branched into the unit.

construction by the hobbyist.

The use of a perfboard or other assembly method is certainly possible as no part of the CallDirector circuitry is especially sensitive to component spacing or orientation. The only important considerations are that appropriate heatsinking for IC3 be provided, and C10 must be connected as close to IC3 as possible. Since IC3 is in a standby mode at all times except when a ring is actually being generated, the heat sink need only be about 2 square inches of aluminum sheet metal bolted to IC3's tab with appropriate hardware. Many commercial heat sinks are available for that device at very low cost. The tab of IC3 is at ground potential, so no mica insulator and shoulder washer insulation kit is needed.

If you decide to use a PC board, it is a good idea to begin by loading the low-profile components (such as resistors) first. Keep in mind that excess soldering heat can be damaging to semiconductors, such as diodes, transistors, and ICs, so those components are best installed last. Another general reminder is the observance of component polarity. All components except resistors, ceramic-disc and polyester capacitors, MOV1, and T3 require a specific direction of installation.

Many of the ICs used in the CallDirector are CMOS logic chips, which are sensitive to static electricity. Always keep them in their shipping packages until you are ready to install them. Experience over many years has shown that basic logic CMOS devices aren't nearly as electrically fragile as many believe. Still, caution and care are essential.

The integrated circuits are oriented by either an embossed dot or a notch on one end of the case which identifies pin 1. Electrolytic capacitors are marked to identify polarity and many have one longer lead—usually the positive lead. Diodes have a dark band on one end of their case to identify the cathode. Light-emitting diodes have a "flat" in the body which identifies the cathode. Sometimes they also have a longer lead, which indicates the anode.

The excess lead trimmings from the resistors, capacitors, and diodes can be used as jumpers. The jumpers all have the same spacing, so that several can be formed together, speeding that part of the assembly. Next, mount all diodes making sure to note the locations of Zener diodes. Mount the transistors, bridge rectifiers, capacitors, and all other components except integrated circuits in that approximate order. All ICs are then installed with IC3 and its heat sink being last.

Before mounting IC3, attach the heat sink to the board. The heatsink listed in the Parts List is secured with either two self-tapping machine screws or solder tabs at the base of the heat sink. Orient the heat sink and place it on the board. If solder pins are provided, be sure the heat sink is tightly against the top surface of the board before soldering its pins. Soldering the heatsink will require more heat than that which is typically available from a small soldering iron of about 15- to 25-watt capacity considered safe for PC board work. A 100-watt soldering gun will work nicely for the heatsink. Apply sufficient heat to thoroughly melt a generous amount of solder around each heatsink pin. If you use a screw-mount heatsink, be sure to securely tighten the screws without overtightening them. Once the heatsink is mounted, place IC3 in position. Insert the pins through the PC board and attach IC3 to the heatsink with a 4-40 screw and hex nut and a small amount of heat-transfer compound.

Cabinet choice is not critical since there are no special ventilating or shielding requirements and there are no exposed dangerous voltages if a wall-mount plug-in transformer is used.

Hookup and Testing. Because all CallDirector control functions are performed through DTMF inputs from the house telephones, the unit is connected at a common point in the house telephone wiring between the telephone company and all of the telephones in the house. That location is sometimes called the phone company "demarcation" point. It is usually in an out-of-the-way place such as a basement or utility room. Connecting all telephones in the house to the CallDirector is best so that hold, transfer, and intercom service is provided throughout the entire house. In connecting the CallDirector to the telephone wires, follow the diagram in Fig. 5.

There are only two adjustments needed for proper operation of the CallDirector: the ringer-voltage adjustment control (R8) and the music-on-hold volume adjustment (R32). Both of those adjustments are made after the CallDirector has been powered up and its main sup-

ply voltages are confirmed to be at their proper levels.

Before applying power to the CallDirector for the first time, measure the resistance between both of the 16- and 5-volt supplies and ground. Both should measure over 1,000-ohms. If they don't, check the PC board for misplaced components or solder bridges between the traces. Once that check is done, connect a voltmeter across the 5-volt supply and ground, and apply power to the CallDirector. If the 5-volt supply doesn't come up, disconnect power immediately and troubleshoot the problem. If the voltage is correct, measure the 16-volt supply. That supply is unregulated and should indicate nearly 18 volts without the ringer operating, but should not be less than 16.5 volts.

For ring-voltage adjustment, connect a telephone to the CallDirector with a REN of as close to 1.0 as possible. Set R8 at an initial position of about ten o'clock. Connect a voltmeter capable of measuring rms voltages of 120 volts at 20 Hz across the CallDirector output phone line, or across the secondary of T2, whichever is more convenient. Note that most modern digital multimeters will be able to measure that voltage with sufficient accuracy.

Pick up the phone and dial "###", which will put the outside line on hold. It's best to actually have someone call you during the test. The reason is that many phone companies will drop loop current within a minute or so after a subscriber's phone goes off-hook without actually calling someone. If the CallDirector were in a hold condition on such a line, the loop current drop would be interpreted as a caller hanging up and would reset the CallDirector without its generating a ring after the 80-second delay. After the approximate 80-second delay, the CallDirector will begin generating a standard ring. There should be enough time during the ring intervals to adjust R8 for a nominal ring voltage of 90-volts rms. Momentarily lifting the phone off-hook will reset the CallDirector and discontinue the ring.

The music-on-hold level is most easily set through a trial-and-error procedure. Connect a music source to J4. That can be any source having a line output such as a radio tuner. A small portable monaural radio with a 120-volt adapter and a headphone jack is a reliable and inexpensive music-on-hold source. Buy or make a cable to mate the radio headphone jack to the jack used for J4 on the CallDirector. Note that many monaural radios actually have stereo headphone jacks to accommodate inexpensive "Walkman" style headsets. Be sure to consider that when either buying the connector for making the cable, or choosing a pre-made cable.

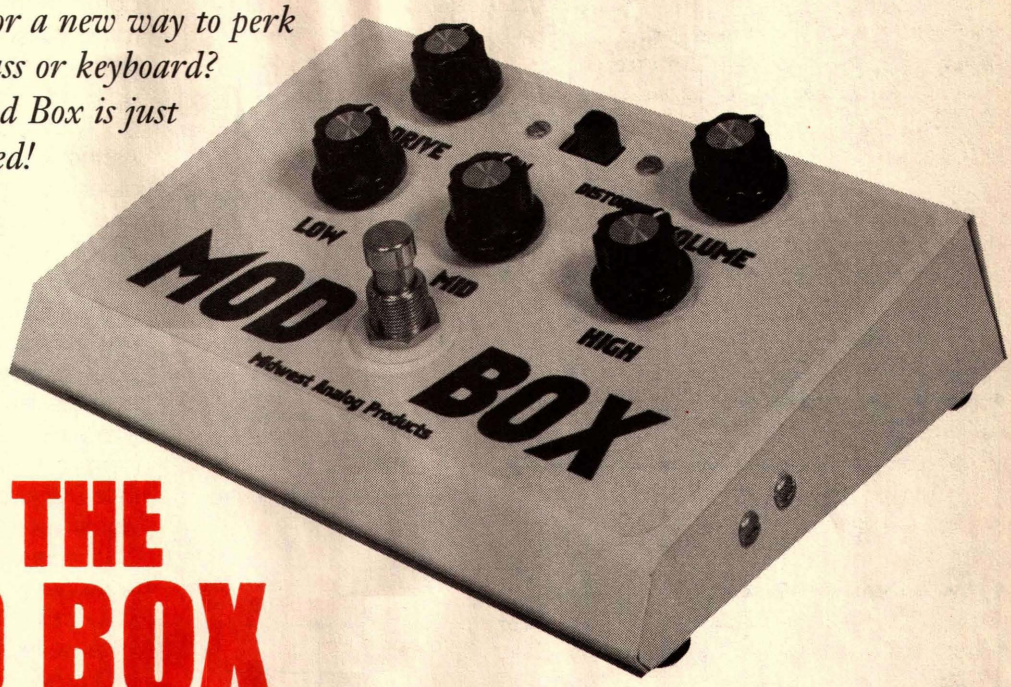
If a line level connection is to be made, simply plug the tuner into the CallDirector with a standard RCA patch cable. If a portable radio is used, tune in the desired station and set the speaker volume to a comfortable listening level before plugging in the mating cable to the CallDirector. Set R32 to about ¼-turn as an initial setting. Call a friend and place them on hold. Pick up the phone after several seconds and readjust the volume depending on the report by the friend. Repeat the hold and adjustment as needed until the music is at a comfortable level. The only caution is to not make music on hold too loud as crosstalk onto other phone circuits is possible if the line is overdriven.

The CallDirector should now be checked for all operating features and all ring selections. The following is a test checklist. The first part is performed with another party on the line.

1. "###"—Standard hold. After 80 seconds a standard ring begins. Pick up the phone.
2. "##1"—Selective hold. There should be an immediate generation of 1 short ring. Pick up the phone.
3. "##2"—Selective hold. There should be an immediate generation of 2 short rings. Pick up the phone.
4. "##3"—Selective hold. There should be an immediate generation of 3 short rings. Pick up the phone. Confirm with the caller that audible ring back could be heard.
5. "##4"—Selective hold. There should be an immediate generation of 4 short rings. This time have the helper hang up and confirm that the CallDirector stops ringing within no more than about one minute of the caller hanging up. On most phone systems, the ring line current is interrupted much sooner, often within five or ten seconds.
6. "##94"—Intercom and ring four. A caller is not needed for this test. There should be an Immediate generation of 4 short rings, but the incoming phone line is not held off-hook. Pick up a second phone and confirm that both telephone voice circuits are operational by speaking into one phone and hearing the voice in the earpiece of the other phone. The earpiece should otherwise be silent. Momentarily place the phone on-hook to return a dial tone.
7. Repeat step 6, but this time coordinate the timing of the test so that an outside caller will call in while the intercom is being used. When the call comes in, an electronic ring signal should be heard in the earpiece. Momentarily place the phone on-hook to connect to the caller.
8. Repeat step 6, and while checking the telephone voice circuit, disconnect power to the CallDirector. The phone should immediately connect through to the incoming phone line.

If all of those tests are completed satisfactorily, the CallDirector is ready to be placed into service. The CallDirector unit is rugged and dependable and is conservatively designed for many years of trouble-free service. The more you use the CallDirector, the more you will like its step-saving features. So, go ahead enjoy, and be spoiled by your new phone system! But be ready, because your friends will probably want a CallDirector too. Unfortunately, they can't get one of these things at any price, not even from the phone company. Ω

Are you looking for a new way to perk up your guitar, bass or keyboard? If so, then the Mod Box is just the project you need!



BUILD THE MOD BOX

BY THOMAS HENRY
AND JACK ORMAN

Musicians are always looking for new and different ways to change, modify, or control the sound of their instruments. There are many types of "effects" boxes available either assembled and tested or in kit form to help fill that need. Unfortunately, many of those devices are limited to one type of instrument, one type of effect, or in many cases, both.

The Mod Box is much more than just a fuzz circuit or tone control. It combines elements of each in order to give you unparalleled mastery over the sound of your instrument. Although straightforward to build, the Mod Box represents some of the best of modern thinking on the subjects of distortion and equalization, yielding a circuit capable of many superior sounds. Used with an electric guitar, for example, it can emulate a broad range of different guitar/amplifier makes and models. And best of all, its careful design includes features demanded by the most discriminating performers, professional and amateur alike.

Why is it called the Mod Box? For one reason, it can easily modify musical sounds in many different ways. The circuit can also be easily modified to match just about any instrument or performance situation. That feature alone sets it apart from the crowded field of effects boxes. Additionally, the sounds it creates really are quite mod! But don't let that scare you off. The Mod Box is equally at home in rock and roll, blues, country western and jazz settings, whether you're a seasoned pro, or just like to noodle around on the weekends. So if you're ready to unlock a whole new world of musical sounds, read on to see how to build and use the Mod Box.

How It Works. The schematic diagram for the Mod Box, seen in Fig. 1, can be divided into four principal sections: an input buffer, a distortion stage, a 3-band equalizer, and an output conditioner. Those sections are all built around one of the four op-amps contained within IC1, a TL074. That device is a low-current, low-noise, quad op-amp. It is perfectly suited for electronic music and audio applications.

The output of an instrument is connected to the Mod Box through J1. The output level of the pickups on guitars and basses will probably be around 100 millivolts peak-to-peak, but can be as high as 1 volt. A keyboard might put out several volts. Any of those voltage levels are acceptable to the Mod Box. To avoid loading the instruments output circuit, the input signal is buffered by IC1-a. Any DC voltages present in the input are blocked by C12, letting only the audio signal through, while R20 holds the noninverting input of IC1-a when no signal is present. Any radio-frequency interference is shorted to ground by C1.

The gain of the input buffer is set to about 3 with R10 and R18. That will give a bit of a boost to instruments that have weaker signals. Those resistors were deliberately chosen to be rather low in value in order to keep the inverting input of IC1-a

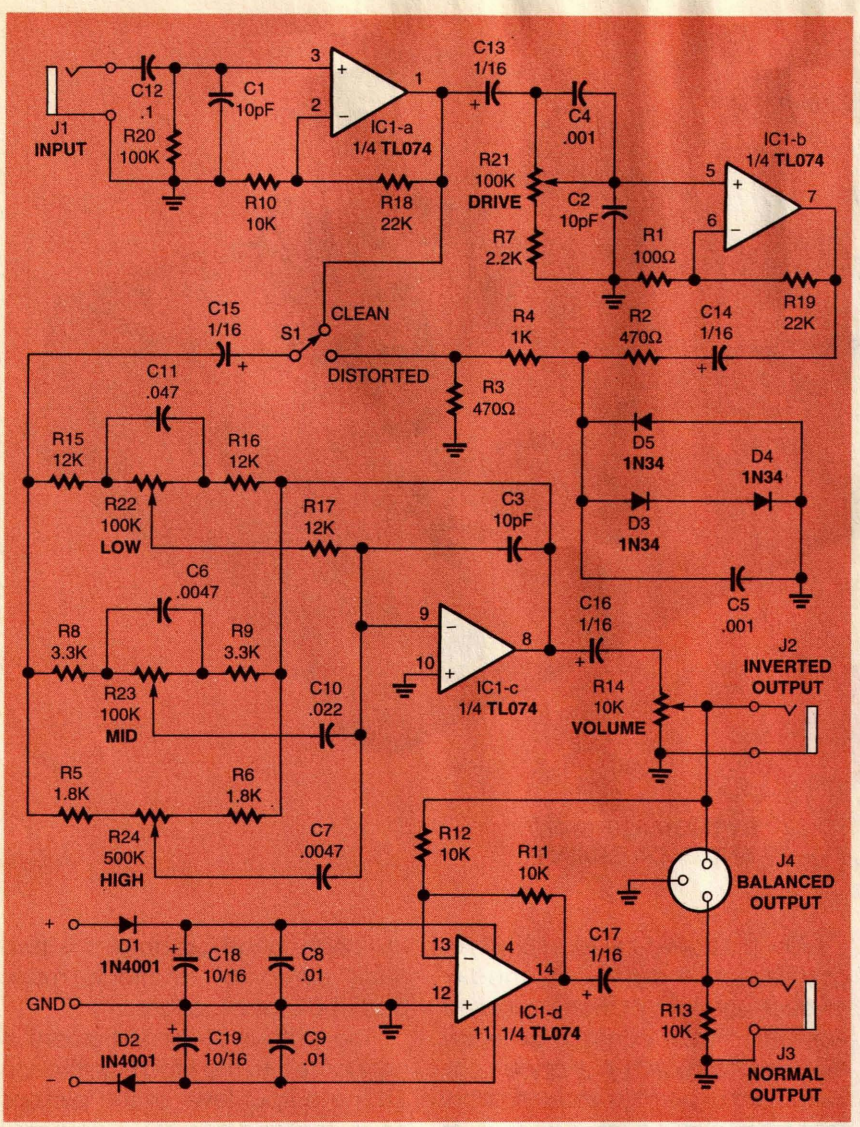


Fig. 1. The Mod Box is designed around a TL074 quad op-amp. Not only is the circuit quite versatile, it can be modified easily for any special requirements—most of which only require component substitutions.

from acting as an antenna, which could pick up radio interference.

The output of the buffer is split in two. One path heads directly to S1; the other is connected to the distortion stage. The amount of distortion can be varied by adjustments to R21, the Drive control. The lower limit is set by R7. That keeps the Mod Box from going silent altogether at low settings. Another subtle design touch is the inclusion of C4. Many "fuzz" circuits in the past had a noticeable loss of treble at a lower input level. The result was a rather dead sound at low settings. In the Mod Box, there is no real change in frequency response when R21 is turned up. But when turned down, a disproportionate amount of high frequencies are passed by C4, resulting in a livelier-sounding instrument at all control settings. Capacitor C2 has the same function as C1—removing any undesirable RF.

The signal is then greatly amplified by IC1-b. The gain is set to about 200 by R1 and R19. Similar to the design of the input buffer, the values of R1 and R19 are kept small in order to minimize noise and induced 60-Hz hum.

The greatly amplified signal, whose ultimate level depends on the setting of R21, is applied to the diode-clipping stage. In the past, many fuzz boxes employed hard clipping. That is really nothing more than so severely overdriving the input of an amplifier that it acts like a comparator. The clipped sound is rather raspy and hollow in nature. A better method, favored by knowledgeable musicians, is to simply apply the signal across some diodes. As the signal level is increased, the diodes progressively conduct more and more, leading to a soft clipping effect. Most people would say that the sound is "warmer" and reminiscent of tube distortion that is so popular nowadays. But the Mod Box goes two steps further. Notice that the clipping diodes specified (D3 through D5) are the old-fashioned germanium type. As it happens, those type of diodes turn on with a slightly more rounded edge than silicon ones. Moreover, the diodes have been arranged asymmetrically to clip the negative peaks at a lower level than the positive ones. That produces a sound that emphasizes even-order harmonics, which is generally perceived as smoother and more pleasing to the ear.

Incidentally, with R21 at a low setting, the Mod Box creates a "chunky" effect, characteristic of old-fashioned blues guitars. If you open up R21, you can obtain some screaming sustain—perfect for solo work in a hard-rock setting.

But back to the diode network. R2 limits the current flow somewhat, which takes a bit of the grit out of the sound. To smooth things even more, C5 removes some of the high frequency components. Finally, the voltage drop across the diodes is a trifle hefty (about 1V peak-peak total) so R3 and R4 reduce the level a bit. That keeps the next stage from being overdriven—a most undesired type of distortion!

Switch S1 selects whether a clean or a distorted signal is sent to the equalizer stage. That stage is formed by the many capacitors, resistors and pots encircling IC1-c. The equalizer is a standard design which has been around for years and works very well for electronic music. What makes it especially attractive is that it permits independent control of the low, mid-range, and high frequencies passing

through it. The center frequencies for the three ranges are about 30 Hz, 1 kHz, and 10 kHz, respectively. The design equations are beyond the scope of this article, but might be found in various reference sources, such as the 1977 edition of the *Audio Handbook* from National Semiconductor.

The signal enters the equalizer through C15. The actual tone shaping is done by the network within the feedback loop of IC1-c. The capacitors in the equalizer should be extremely stable. Mylar, polypropylene, or polystyrene types are recommended. Also observe that R22, R23, and R24, the Low, Mid and High controls, respectively, must have linear tapers. That ensures that the center position of each is a flat setting with no boosting or cutting of frequencies. Once again, C3 attenuates any RF signal that might be itching to inject itself, and by limiting gain at frequencies above the audio range, serves to stabilize IC1-c.

The output at pin 8 of IC1 could be quite hefty by now, so R14 acts as a volume control in order to tame things a bit. But notice that the signal at J2 is inverted with respect to what went into the Mod Box. That might not matter in many situations, but could be disastrous in others. For example, suppose you are recording in a studio and wish to mix some straight signal in with the output of the Mod Box. As you turn up the mixer controls, the two signals will be 180° out of phase with each other. The processed signal will be subtracted from the straight signal which will probably lead to a thin sound.

To avoid that unpleasant circumstance, the output is also routed to IC4-d, which is wired as another inverter. The signal present at J3 will then be in phase with the original input at J1. Before you start grumbling about the need for yet another op-amp, notice that something else comes along for free. Since both a normal and inverted output are available, we can also include a balanced output, J4. Many professional and semi-professional mixers, processors, and amplifiers have balanced-line jacks, so a balanced output on the Mod Box makes a perfect addition. In order to keep things truly balanced, R13 is included to match R14.

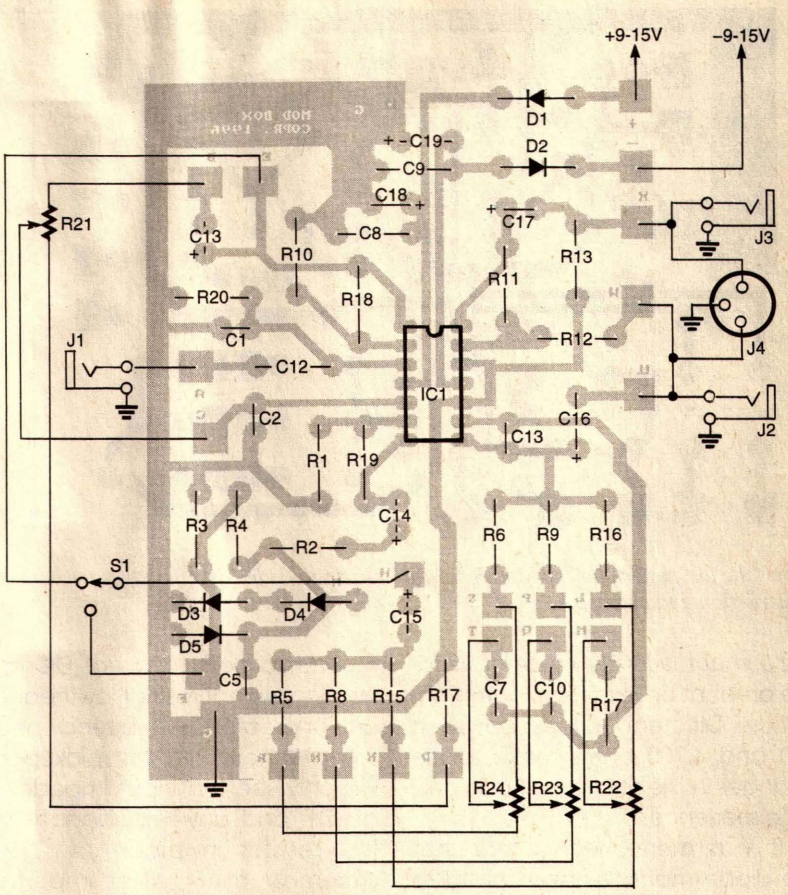


Fig. 2. If you use a PC board based on the foil pattern, follow this parts-placement diagram for all component locations.

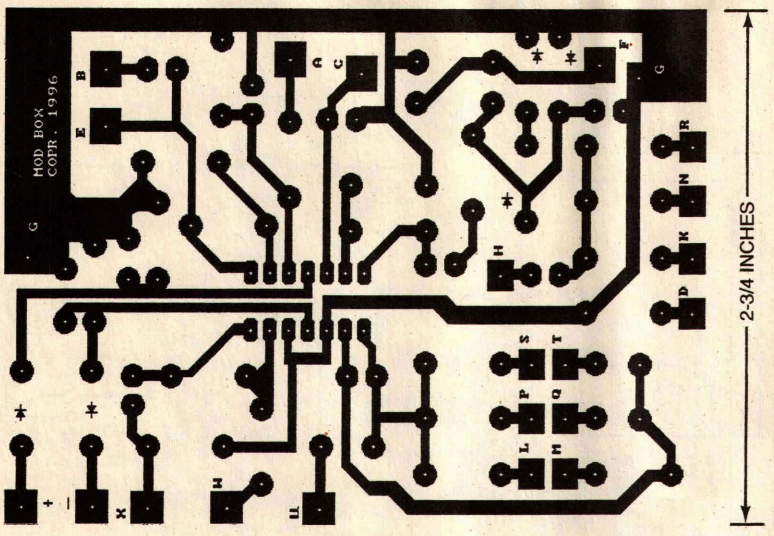
Since IC1 is the only active component in the Mod Box, the power supply can be anything from ±9 to 15 volts. Capacitors C8, C9, C18, and C19 help decouple and bypass any noise or ripple present in the power source. For added protection, D1 and D2 prevent circuit damage if someone attempts to connect the supply backwards. That is especially important when using 9-volt batteries.

Mod Box Mods. Before we sit down and build the Mod Box, let's take a look at a few modifications to the basic circuit that might be useful.

One change that requires no modifications to the circuit is using a substitute chip for IC1. There are a variety of op-amps that have the same pinout as the TL074. Examples of those components are the LM348, LM387, TL084, and LF444. Substituting another chip might have advantages in power consumption, noise levels, or even the fact that the component is in your spare-parts box!

A bass player would probably want to not emphasize higher frequencies. In that case, C4 could be eliminated or made switch-selectable from the control panel. You could also increase the value of C12 to emphasize the bass, or decrease it to brighten the sound even more.

The quality of the distortion can be made more muffled by increasing the value of C5 to about 0.01 µF. That will give an old-fashioned blues-guitar sound. Decreasing the value of C5 to about 100pF—or even leaving it out—will result in a crisper rock effect. You can also



Here's the foil pattern for the Mod Box. A simple single-sided design makes for both easy construction and changes.

experiment with the value of R2 for the amount of "grittiness" of the distortion. Different values between 100 and 4,700 ohms make subtle changes in the sound that can only be experienced.

It was mentioned before that the diode matrix is unbalanced to stress even harmonics for a "warmer" sound. That effect can be raised even more by eliminating one side of the diodes completely. If, on the other hand, D4 is eliminated and a jumper wire put in its place, the clipping will be more symmetrical. That will emphasize the odd harmonics, giving the sound a more "solid-state" feel.

The clipping diodes could also be substituted with different values. Changing the germanium units to silicon types will give a more buzzy effect. A higher output volume is achieved by using LEDs, which might or might not light up. That depends on the amount of current flowing into them, which is controlled by R2.

A better method of connecting the Mod Box to a guitar with a magnetic pickup is to eliminate R20 and replace C12 with a 1,000-ohm resistor. That arrangement has several advantages over the generic input circuit shown in Fig. 1. The resistor will give some static-electric protection to IC1. Without C12 in the audio path, a direct DC connection will not restrict low frequencies or create low-frequency phase shifts. Without R20, the pickup coil will only see the input impedance of IC1, and any impedance from the resistor in place of C12 is extremely minor. Most important, the non-inverting input of IC1 is being terminated to ground through the 1,000-ohm resistor. That results in a very good signal-to-noise ratio, especially if the Mod Box is going to be built directly into the guitar.

An additional effects circuit can be connected into the Mod Box circuit with the addition of a pair of jacks between the common terminal of S1 and C15. If a switched jack is used for the jack connected to S1, the Mod box will function normally if no plug is inserted. Simply connect the switch portion of the jack to C15, which completes the normal audio path. When a plug is inserted in the jack, the audio signal from S1 is sent to the jack instead of C15. The second jack will complete the loop by feeding the output of the external circuit back into the Mod Box. The second jack could also be used as a monitor or intermediate output from the Mod Box for some complex audio patching.

The entire Mod Box could also be bypassed with an additional DPDT switch connecting J1 and J3 either to their respective connections to the Mod Box PC board or to each other. That way, any settings to the equalizer can be switched in and out at will. If the switch you are using tends to add clicks or pops to the audio signal when switching, a 1-megohm resistor may be added between the Mod Box's input (C12) and ground.

Power Supply Options. The Mod Box can be powered by many different methods, depending on how the unit is to be used. A pair of 9-volt batteries will power a floor unit nicely. As an added touch, use stereo jacks for J1 and J3, with the ground side of the batteries connected to either ring terminal of the jacks. When a mono plug is inserted into the stereo jack, the ring contact will be shorted to ground, turning the Mod Box on. Either one battery can be connected to each jack, or both batteries can be tied to one jack or the other.

A more traditional approach would be to use a separate switch for the batteries. Using a DPDT switch instead of a DPST switch would allow you to use the on-off switch as a selector for internal batteries or an external split power supply rated between 9 and 15 volts.

A clever way to power the Mod Box is to increase the size of C18 and C19 to 470 μF and tie the two power inputs at D1 and D2 together. That will allow you to use a 9-volt AC wall transformer. Because we now have a dual half-wave rectifier circuit with fairly large capacitors, do not use a transformer larger than 9 volts, or IC1 will burn out from overvoltage.

If the Mod Box is to be mounted in a rack system, you can easily tap into the power supply that feeds the rest of the rack modules.

How To Build The Mod Box. The first step in building the Mod Box is to decide which features you need and which you don't. The previous section discussed several different ways the circuit can be modified for your own situation. For example, guitar players might want to build the

Mod Box as a battery-powered floor unit, using a push-on push-off switch to enable and disable the effect. Bass players will no doubt want to boost the low-end response and probably won't need the balanced output connector. Keyboardists and studio musicians might prefer a rack-mounted version with all of the bells and whistles tossed in.

Once you've decided upon a configuration, gather together the required parts. None of these should be hard to find or expensive. While a hand-wired perfboard approach might be possible, a printed-circuit board will give the neatest and most stable results. You can etch a board yourself using the supplied pattern. The parts-placement guide in Fig. 2 is based on the printed-circuit pattern. An etched, drilled and tinned circuit board as well as a kit of parts are available from the source given in the Parts List.

The Mod Box is a straightforward circuit to build, but it is essential that it be built as neatly as possible. Since there are some high gains involved, sloppy workmanship could spoil its operation with spurious oscillation, hiss, and hum. As a general rule of thumb, keep the inputs away from the outputs, and if any wire from the circuit board to the front panel is longer than 6 inches, use shielded cable. To avoid ground loops, which can lead to serious hum problems, be certain the shield is grounded on one end only.

Some obvious tips when building the Mod Box include being careful to observe the orientations of the polarized devices like the diodes, IC, and electrolytic capacitors. Remember that some of the component locations on the board might be left empty depending on the modifications you decide to use. Note that C4, C6, and C11 mount behind potentiometers R21, R23, and R22 respectively—not on the printed-circuit board.

What sort of enclosure will you need? If you plan on using the Mod Box on stage, then a sloped-face floor box made of $^1/_{16}$-inch steel is perhaps best. A floor unit should have the DPDT push-push switch mounted in a central location. That lets the guitarist or bassist punch in the effect with a stomp of the foot. That is why effects boxes geared toward stage performance are sometimes referred to as "stomp" boxes. With that type of enclosure, the PC board is mounted on the bottom of the box with some small nuts and screws. A thin piece of insulating foam underneath keeps the board from shorting out against the metal cabinet.

Another possibility is a rack mounted version. The front panel can be made of $^1/_8$-inch aluminum stock, with the industry standard dimensions of $1\text{-}^3/_4 \times 19$ inches. After cutting and drilling the panel, it can be given a coat of colorful epoxy paint and labels applied to the controls. One method for creating labels is a laser printer or copy machine and either self-stick labels or clear label material with a peel-off backing.

Once the Mod Box has been built and power applied, patch an instrument into J1 and connect the desired output (J2, J3, or J4) to an audio amplifier. To avoid any ear-splitting surprises, keep the volume low initially.

Making Music With The Mod Box. This description assumes that a guitar is being used, although the following comments apply similarly to other instruments. Set S1 to the Clean position, set the Low, Mid and High controls to their center positions, and the Volume control low. The Drive control has no effect when the

continued on page 60

PARTS LIST FOR THE MOD BOX

SEMICONDUCTORS

IC1—TL074 quad op-amp, integrated circuit
D1, D2—1N4001 silicon diode
D3-D5—1N34A or 1N60 germanium diode

RESISTORS

(All resistors are $^1/_8$-watt, 5% units, unless otherwise noted.)
R1—100-ohm
R2, R3—470-ohm
R4—1,000-ohm
R5, R6—1,800-ohm
R7—2,200-ohm
R8, R9—3,300-ohm
R10-R13—10,000-ohm
R14—10,000-ohm potentiometer, audio taper
R15-R17—12,000-ohm
R18, R19—22,000-ohm
R20—100,000-ohm
R21—100,000-ohm potentiometer, audio taper
R22, R23—100,000-ohm potentiometer, linear taper
R24—500,000-ohn potentiometer, linear taper

CAPACITORS

C1-C3—10 pF, ceramic disc
C4, C5—0.001 µF, Mylar
C6, C7—0.0047 µF, Mylar
C8, C9—0.01 µF, ceramic disc
C10—0.022 µF, Mylar
C11—0.047 µF, Mylar
C12—0.1 µF, Mylar
C13-C17—1 µF, 16-WVDC, electrolytic
C18, C19—10 µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

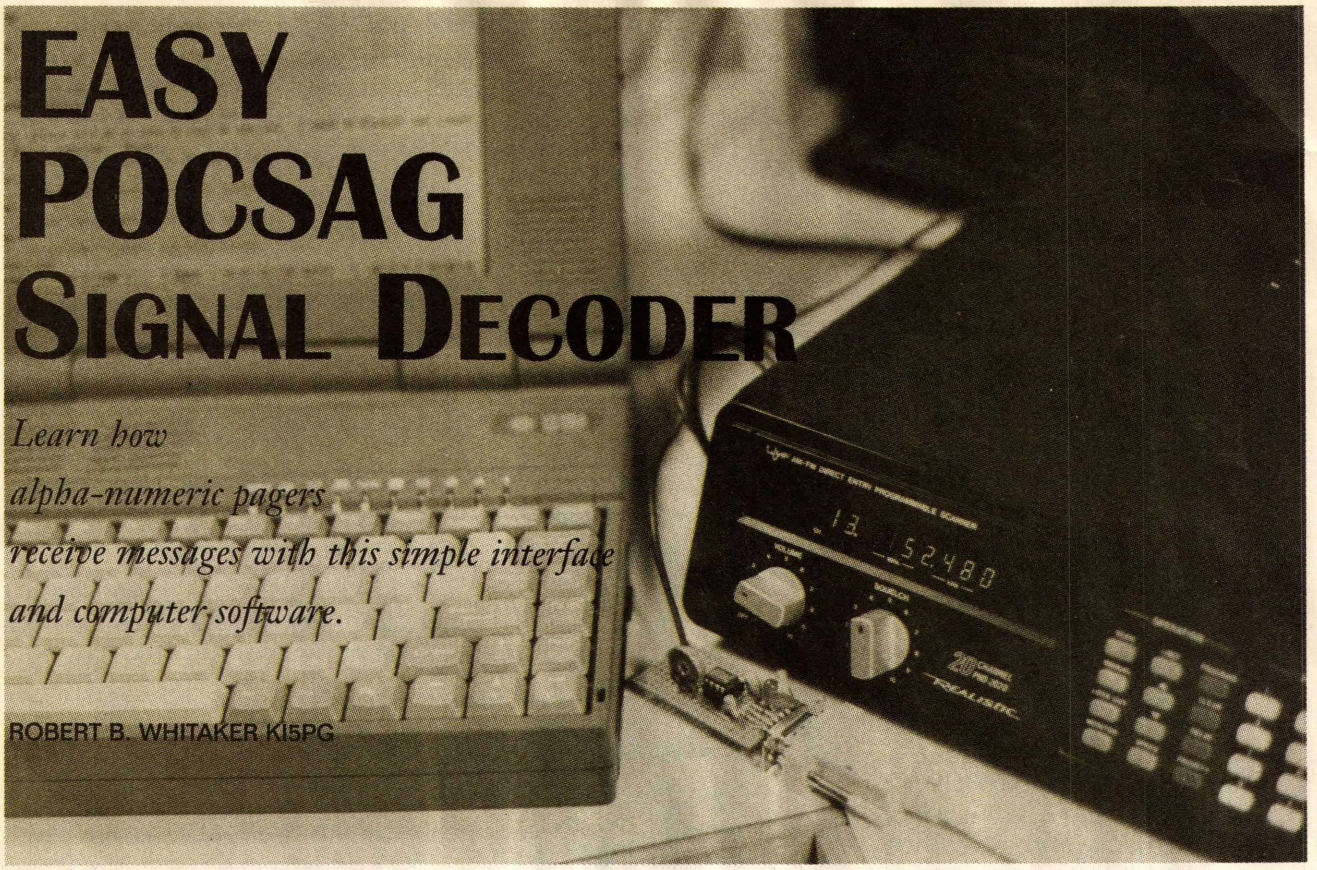
J1-J3—¼-inch phone jack
J4—XLR connector
S1—SPDT switch
IC socket, battery holders, battery clips, printed-circuit board or perfboard, enclosure, knobs, wire, solder, etc.

Note: The following items are available from: Midwest Analog Products, P.O. Box 2101, North Mankato, MN 56003. Etched and drilled printed circuit board, $15.00. Kit of parts including etched and drilled circuit board, resistors, capacitors, semiconductors, socket, SPDT switch, potentiometers, ¼-inch stereo phone jacks, 9V battery clips and holders (does not include enclosure, knobs, XLR connector, DPDT stomp switch, wire or solder), $39.95. Heavy-duty DPDT push-push stomp switch, $8.00. U.S. and Canadian orders add $2.00 S/H for the printed circuit board alone, $4.00 S/H for the printed circuit board and kit of parts, or $1.00 S/H for the stomp switch. Write for shipping information to other countries. Prices shown in US dollars. Remit U.S. funds only. MN residents add 6% sales tax. Money orders and checks only. Prices and terms subject to change without notice. For up-to-the-minute circuit modifications and suggested settings, be sure to check out Midwest Analog Products on the Internet World Wide Web Homepage: http://prairie.lakes.com/~map. E-mail: map@prairie.lakes.com

EASY POCSAG SIGNAL DECODER

Learn how alpha-numeric pagers receive messages with this simple interface and computer software.

ROBERT B. WHITAKER KI5PG



Have you ever thought about how those alpha-numeric pagers work? Have you heard erratic buzzing and beeping digital signals while scanning across the VHF or UHF bands? Message services for small, portable pagers have become as widespread as cellular telephones.

But is it possible to decode the pager messages flying around the airwaves? It is easy to do from a technical point of view, but the information contained in the radio signals is a completely different matter from a legal point of view. The willful intercepting a non-broadcast-type signal meant for private communication other than a tone-only signal is a violation of law and carries the same penalty and criminal status as intercepting cellular-telephone calls.

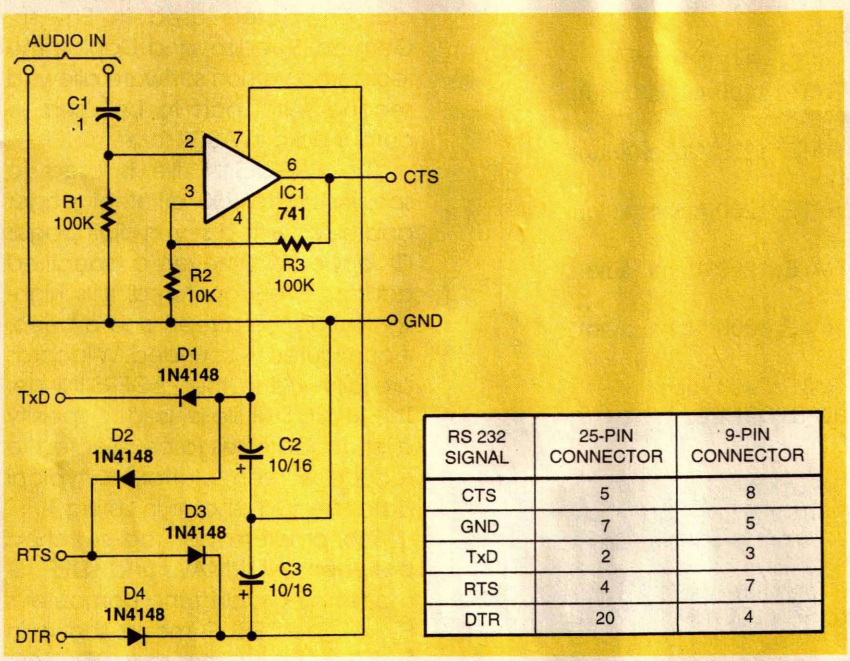
That said, a scanner, a simple interface circuit, a personal computer, and a shareware program available through the Internet are all you need to set up your own pager-signal monitor. The monitor described here will decode 512-, 1200-, and 2400-baud data streams. An additional feature of the software is that it can be configured to only decode signals sent to your own pager or a pager for which you have permission from the owner to receive. If the monitor is used solely on ham bands for monitoring ham pagers, any legal limitation might not apply. To be safe, always check with a legal advisor before using the decoder in your area.

What is POCSAG? POCSAG stands for Post Office Code Standardization Advisory Group. That advisory group has established the standard signal code and transmission protocols now in use by the vast majority of pager services. POCSAG is sent by frequency-shift keying (FSK) an FM-carrier wave at ± 4.5 kHz. A list of commonly-used frequencies for POCSAG signals are shown in Table 1. Check with your pager service to find the actual frequency they use.

The decoder will work with regular speaker audio from an external speaker jack or headphone jack, but will work much more reliably with raw de-emphasized audio taken directly from the discriminator of the receiver or scanner. Scanners or radios that are 9600-packet ready should be useable without any further modifications. Other scanners or radios that don't have an audio or discriminator out-

WARNING!

Please note that unauthorized electronic communications interception is illegal under Federal and State Law. In addition Federal law renders illegal the intentional manufacturing, assembling, possessing or selling of any electronic, mechanical or other device, knowing or having reason to know that the design of such device renders it primarily useful for the purpose of surreptitious interception of oral or electronic communications. Federal law imposes both civil and criminal penalties for violations of the applicable statutes. Thus, the use of the POCSAG Signal Decoder described in this article is intended for and should be restricted to educational, scientific and/or informational purposes. This is not intended to constitute legal advice and readers are advised to obtain independent advice as to the propriety of their use thereof based upon their individual circumstances and jurisdictions.



RS 232 SIGNAL	25-PIN CONNECTOR	9-PIN CONNECTOR
CTS	5	8
GND	7	5
TxD	2	3
RTS	4	7
DTR	20	4

Fig. 1. The interface circuit for the POCSAG decoder is simply a comparator that takes the demodulated audio from a scanner or radio receiver and changes it to digital pulses that can be read by the software. Power for the circuit is derived from the unused pins on the serial port.

PARTS LIST FOR THE POCSAG SIGNAL DECODER

IC1—LM741 op-amp, integrated circuit
D1–D4—1N4148 silicon diode
R1, R3—100,000-ohm, ¼-watt, 5% carbon resistor
R2—10,000-ohm, ¼-watt, 5% carbon resistor
C1—0.1-µF, ceramic-disc capacitor
C2, C3—10-µF, 16-WVDC, electrolytic capacitor
Socket for IC1, PC board, DB-25 or DE-9 female connector, hardware, wire, solder, etc.

Note: The following items are available from: L0pht Heavy Industries, POCSAG Project Division, P.O. Box 990857, Boston, MA 02199-0857; Complete kit with registered software, $59.95; Assembled and tested unit with registered software, $89.95; Complete kit with unregistered software, $19.95. Please add $5.05 for shipping and handling for each unit ordered. All payments are to be in US funds. Accepted forms of payment are cash, check, or money order only. Please make all checks payable to L0pht Heavy Industries. No COD orders will be accepted. Shipment is via first-class US mail to anywhere in the world. Massachusetts residents please add 5% sales tax. Allow four to six weeks for delivery.

put might need to be modified in order to pick up the signal directly from the discriminator output. If you do not know where the discriminator output is on your radio, and a schematic diagram of your radio is not available, a good place to test as a pick-up point is the high-side lead on the squelch-control knob.

The Hardware. The primary component in the interface circuit of Fig. 1 is a 741 op-amp available at Radio Shack and just about all other major electronics parts vendors. Power for the op-amp can be supplied separately, or could be easily supplied from the unused TxD, RTS, and DTR pins from the computer's RS-232 serial port. Diodes D1 to D4 act as a type of bridge rectifier, making sure the supply pins of IC1 are only connected to the proper voltages from the RS-232 pins.

In this circuit the 741 op-amp is used as a comparator, converting the signal from the receiver into the ±10-volt signal necessary to drive the RS-232 CTS (or DSR) input. That comparator has a positive feedback network, giving hysteresis that helps to recover the data from a receiver's audio output. The level of hysteresis, set by the R2 and R3, can be adjusted for best reception. A 100,000-ohm potentiometer could be substituted for the hysteresis network, allowing the circuit to be fine tuned. If a direct discriminator output is available from the receiver no hysteresis might be necessary; in that case, R2 could be omitted.

Construction. The circuit is simple enough to be built on a perfboard in a few minutes. An alternative is to purchase either a complete kit or an assembled and tested interface from L0pht Heavy Industries (see Parts List), a small group of Boston-area experimenters with a deep interest in electronic hardware. Note that the group has a "zero" in their name and not a capital letter "O".

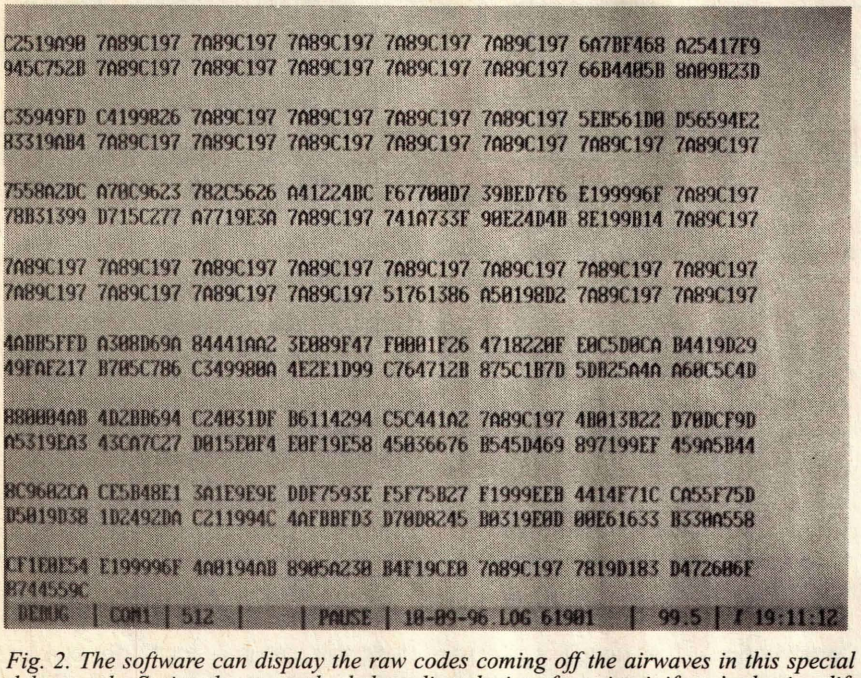
If you opt for the kit, it includes a high-quality, silk-screened, double-sided PC board with plated-through holes measuring about one-inch square. Although the construction is not difficult, that circuit board (not shown here), which is designed to fit inside the hood of a DB-25 pin connector, is rather small and there is little margin for excess solder. The kit includes all documentation for the project, as well as a shareware version of the software to decode the POCSAG signals on a single 3-½ inch PC disk. The interface kit includes some assembly instructions in the README.1ST file, although the kit designers assume that the builder has some experience in soldering and electronics experience. The same information is available through the Internet by visiting the POCSAG Web page at http://www.l0pht.com/~kingpin/pocsag.html.

Incidentally, that Web page is quite interesting. It features a high quality image of the front and back of the interface board. If you look closely, you will notice that the background wallpaper is actually a schematic diagram of the decoder interface shown here.

Whether the interface is breadboarded or built from the available interface kit, a fine tip, well tinned, soldering iron is essential. A fine touch and soldering experience are also beneficial. Poor soldering will undoubtedly contribute to poor results.

LISTING 1

```
20:13:03 04/18/96 ******* LOGGING STARTED *******
20:13:17 RIC: 0546426 FUNC: 0 RATE: 1200 Alpha (auto):
;;TEST POCSAG PROTOCOL
20:13:18 RIC: 0546426 FUNC: 0 RATE: 1200 Alpha (auto):
THIS IS AN EXAMPLE=OF L0PHT
20:13:18 RIC: 0546426 FUNC: 0 RATE: 1200 Alpha (auto):
HEAVY INDUSTRIES POCSAG
20:13:18 RIC: 0546426 FUNC: 3 RATE: 1200 Alpha (auto):
PAGING DECODER.==;
20:13:20 RIC: 0546426 FUNC: 0 RATE: 1200 Alpha (auto):
u0+D90f
20:13:20 RIC: 0546426 FUNC: 2 RATE: 2400 Tone
20:13:46 04/18/96 ******* LOGGING STOPPED *******
```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CF1E8E54 E199996F 4A8194AB 8905A238 B4F19CE8 7A89C197 7819D183 D472686F
8744559C
DEBUG | COM1 | 512 | | PAUSE | 10-09-96.LOG 61901 | 99.5 | T 19:11:12
```

*Fig. 2. The software can display the raw codes coming off the airwaves in this special debug mode. Seeing the raw codes helps adjust the interface circuit if you're having difficulty reading the signal with the particular radio you're using.*

**The Software.** The PC-compatible software, PD-203.zip, is relatively small at only 90 kilobytes, and can be downloaded directly from the POCSAG Web page. It must be dearchived using PKUNZIP or similar decompression software.

The main program file, PD.EXE, is only 79 kilobytes in size. Written by Peter Baston, GW0PJA and AA2DZ in England, it is distributed as shareware. The trial version will time out after about fifteen minutes of use. At that time, storing the decoded pager data to disk is disabled. The registered version of the software can be ordered from L0ght Heavy Industries (see their POCSAG Web page), or the author.

The decoding software is designed to run under MS-DOS. Because the software does all of the decoding, running it in a DOS box under Windows is not recommended because of the overhead Windows produces. The program is configured by editing the PD.INI file. Serial ports 1, 2, 3, or 4 can be used for message input. The bit rate can be selected manually or be set automatically as messages are received, which will decode all bit rates. Display colors for the background, foreground, and status line can be changed to any combination desired. The program is designed for international use and output can be optimized with special characters used in English, German, Swedish, and Danish. The registered version software allows a second serial port to be used to output data in ASCII form.

The PAGERS.INI file is used to specify up to 250 different pager addresses with a seven-digit pager ID code. Whenever a specified address is encountered, it is highlighted on the screen and a beep, if configured, is sounded. Wildcards are allowed in the PAGERS.INI file. The REJECT.INI file is used to specify a list of addresses to be rejected to reduce screen clutter. A typical data stream is shown in Listing 1.

The program can be switched between NORMAL and DEBUG modes by pressing the computer's F1 key. The DEBUG mode, shown in Fig. 2, displays the raw POCSAG codes in hexadecimal format. That is particularly useful for setting up the hardware interface as it gives a visual indication of the number of processing errors in real time. A very helpful status line is shown across the bottom of the screen. That line displays the serial port being used, the current POCSAG bit rate, a PAUSE/RUN indicator, an indication of relative receiving efficiency, a rotating signal indicator, and the current time (taken from the computer's clock). The relative receiving efficiency is expressed in percent. An indication of 100% indicates that all received codes contain no errors. The rotating signal indicator appears to spin when data is being received on the correct pin at the serial port.

The entire project is quite educational. Included with the shareware is a file called POCSAG.TXT written by Brett Miller, N7OLQ, which gives an excellent explanation of the technical aspects of POCSAG signaling and pager operation. It is quite well written, and is perfect for those who are interested in the technical end of pager operations.

**In Case Of Difficulty.** Many unsuccessful electronics projects can be traced to power supply problems. The first place to check for wiring

*continued on page 60*
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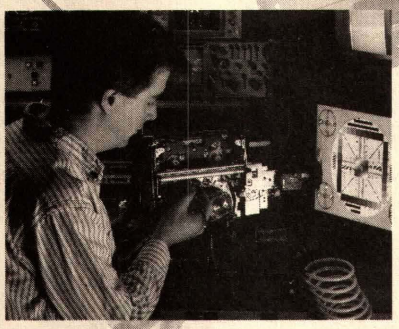

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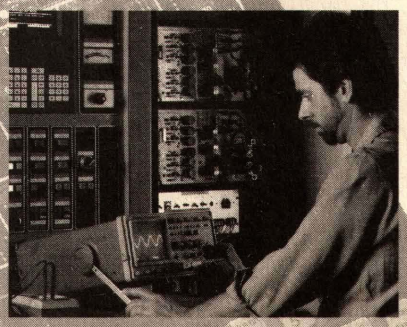

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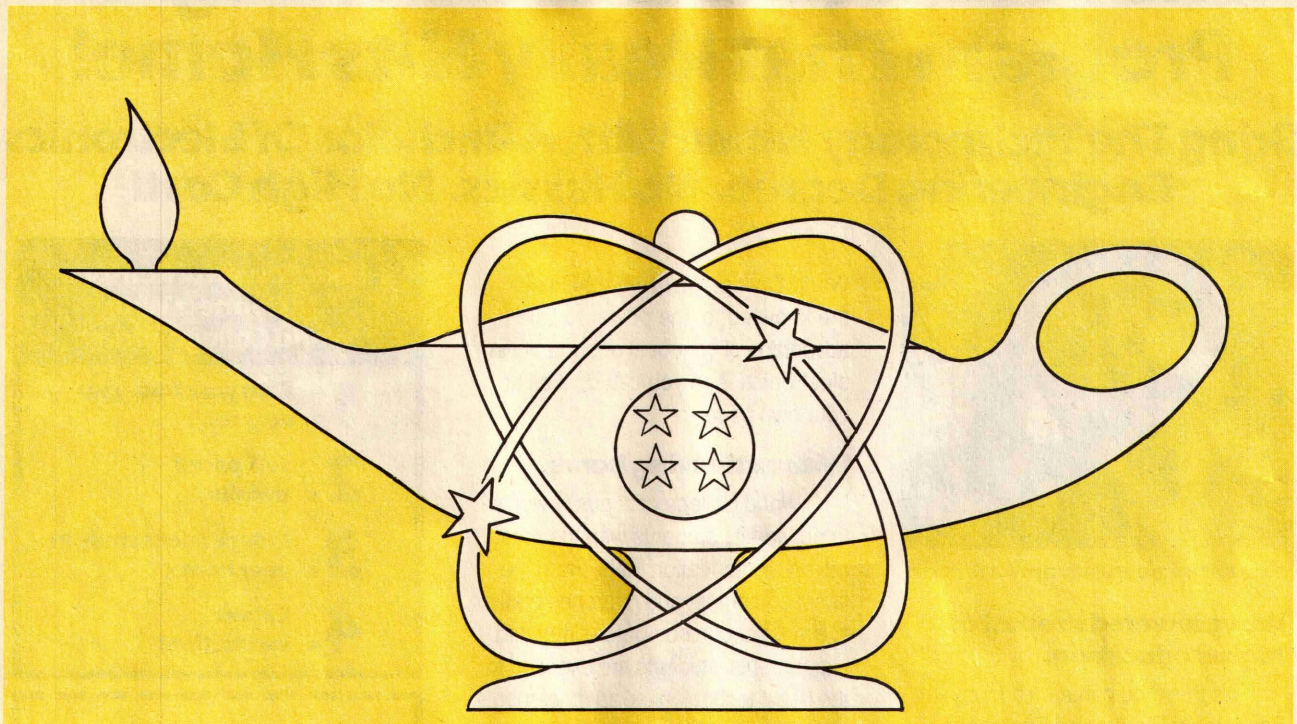

NATIONAL ELECTRONICS TECHNICIANS DAY

A day to honor those electronics professionals who have demonstrated their mettle—and an opportunity to join their ranks

BY BARBARA RUBIN
ISCET Director of Member Services

More than ever, electronics touches nearly every aspect of human activity, and its influence is expanding at a near explosive rate. For example, the latest innovations in banking, business, communications, entertainment, finance, industry, medicine, military systems, and transportation all center around electronics devices and systems, and most of those make use of microprocessors or microcontrollers.

That's also true of the products each of us use every day. Increasingly, cars, cameras, dishwashers, refrigerators, telephones, and TVs—to mention but a few—make use of microprocessors or some other type of "intelligent" controller. And the personal computer is fast becoming a standard appliance in many households. With the increasing popularity of the Internet, that's a trend that is likely to continue.

All of that creates a tremendous opportunity for those with an affinity for electronics. The combination of a growing worldwide demand for electronics products, and the rising complexity of those products and systems, has increased the demand for professionals trained in developing, integrating, maintaining, and repairing high-tech hardware.

Expert electronics technicians participate in the development, prototyping, and testing of new products. They also integrate and maintain all kinds of electronics systems and networks. And they are the people you call when today's generally reliable electronics products malfunction or fail. Their years of professional training and experience permit them to make needed repairs in a timely and economical manner.

In recognition of the skilled electronics technicians of the world, the International Society of Certified Electronics Technicians (ISCET) has proclaimed April 22, 1997 as International Electronics Technicians Day. In addition, the

entire week of April 20 through April 26 has been set aside as a National Testing Week for technician certification.

ISCET's professional certification of electronics technicians has been recognized internationally for more than 32 years; possession of ISCET certification indicates that the holder has met the highest professional performance standards. The voluntary certification program also helps employers to differentiate between qualified applicants and those with less training and skills.

So far, more than 150 ISCET Certification Test Administrators have volunteered to serve during National Testing Week. They will offer CET, CAT, and FCC testing from April 20 through April 26. A complete list of test sites (including **Electronics Now's** editorial offices in Farmingdale, NY) are presented elsewhere in this article.

CET, CAT and FCC Exams. A wide range of CET, CAT and FCC examinations are now available through ISCET. To become fully certified by ISCET, an electronics technician must have at least four years of formal electronics training and experience. In addition, the demanding criteria for certification requires technicians to be knowledgeable in both fundamental electronics and the more advanced theory applicable to their specialty. To demonstrate that, he or she must pass both a 75-question Associate test, covering basic electronics fundamentals, and a 75-question Journeyman test, covering the applicant's area of specialization. The passing grade for each of the multiple-choice exams is 75%. An electronics technician or student with less than four years of experience may apply for Associate-level certification.

The Associate exam requires a broad knowledge of electronics plus the ability to analyze and troubleshoot circuit problems. The basic subjects on which the candidate will be examined include: electronics math, DC and AC circuits, transistors and semiconductors, electronic components, instruments, tests and measurements, and troubleshooting. A technician may also use an Associate exam issued by the Electronics Technician Association (ETA) to qualify to take one of the Journeyman Options.

Individual Journeyman exams focus on many different electronic specialties. The present set includes:

- **Audio**—The questions cover amplifiers and sound quality, system integration, speaker installation, servicing audio products, and troubleshooting audio systems. The exam includes questions on both digital and analog audio.
- **Communications**—The questions address communications circuits and transmission systems, AM and FM transmitters and their adjustment, receiver adjustment, and the servicing and troubleshooting of systems.
- **Computers**—The questions cover binary mathematics, logic gates, the basics of digital electronics and computers, local-area network organization, input and output peripherals, memory, elementary programming, and the troubleshooting of computer systems.
- **Consumer**—The questions cover both digital and analog circuits in consumer electronics products. There are, for example, specific questions on the troubleshooting and servicing of televisions and VCRs, and the operation of applicable service test instruments.
- **Industrial**—The questions cover DC and AC power supplies, transducers, sensors, switches, differential amplifiers, logic circuits, analog and digital circuitry, microprocessors and computer systems, and circuit analysis and troubleshooting of industrial electronic systems.
- **Medical**—The questions cover the principles of electrical safety, basic circuitry, the operation of electronic test instruments, telemetry, and the calibration of typical biomedical Instrumentation.
- **Radar**—The questions cover both pulse and continuous-wave radar operation, radar transmitters and receivers, CRT display systems, radar power supplies, antennas, and the principles of transmission lines.
- **Video**—The questions cover the basics of video, knowledge of NTSC standards, test-signal generation, the principles of video tape recording, VCR tape-drive mechanisms, camcorders, TV cameras and monitors, and the microprocessor as it applies to video.

ISCET is also in the process of developing specialized endorsements to the Journeyman Options that signify advanced expertise in a specific field. Endorsements presently available are VCR and Camera, Camcorder, 8mm, Endorsements will soon be available for Monitors, Data communications, FAX, and Cellular.

CAT Testing. CAT (Certified Appliance Technician) testing opens a whole new field for the trained and certified technician. Whether it's a microwave oven, washing machine, dishwasher, or air conditioner, it's likely to include electronic circuits—perhaps even a microcontroller. The appliance service technicians who service that equipment must learn about electronics as well as learning how to make the electrical and mechanical repairs they have traditionally made.

The Certified Appliance Technician examination is independent of the CET Associate or Journeyman certifications. However, just as for the Journeyman CET option, four years of practical, hands-on experience are required. The CAT examination consists of 100 multiple-choice questions on such subjects as electrical circuits and components, basic electronics, and the operating principles and repair practices for appliances such as refrigerators, ranges, ovens, dishwashers, and trash compactors. Appliance technicians who pass the ISCET CAT are eligible to join ISCET.

FCC Testing. ISCET test administrators can give tests covering FCC elements 1, 3, 5, 6, 7, 8 and 9. Element 1 is Basic Radio Law and Operating Practice. Element 3 is

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Electronic Fundamentals and Techniques Required to Adjust, Repair, and Maintain Radio Transmitters and Receivers. By passing both of those tests, the candidate will qualify for an FCC General Radiotelephone License.

The total gamut of FCC license exams include tests needed for a First Class Radiotelegraph Operator's Certificate (Telegraphy Elements 3 and 4 and written Elements 1, 5, and 6), Second Class Radiotelegraph Operator's Certificate (Telegraphy Elements 1 and 2 and written Elements 1 and 5), Third Class Radiotelegraph Operator's Certificate (Telegraphy Elements 1 and 2 and Written Elements 1 and 5), General Radiotelephone License (Written Elements 1 and 3), Marine Radio Operator Permit (Written Element 1), GMDSS (Global Maritime Distress and Safety Systems) Radio Operator's License (Written Elements 1 and 7), and GMDSS Radio Maintainer's License (Written Elements 1, 3 and 9).

The FCC released its first question pool to examiners on September 6, 1993. The first technician to be FCC certified by ISCET on September 16, 1993 was Antonio C. Gomez of Santa Isabel, Puerto Rico. All FCC Question Pools were upgraded at the beginning of 1995.

In The Beginning. ISCET was founded in 1970 by a committee of Certified Electronics Technicians. Their main purpose was to foster respect and recognition for their profession. By maintaining the rigorous standards of its certification program, ISCET can identify and recognize highly skilled and knowledgeable technicians. Membership is open only to those technicians who have passed the Journeyman CET exam, the CAT exam, or the Associate CET exam.

In addition to receiving regular newsletters and magazines, members are informed about ISCET-sponsored conventions and technical-training seminars. Members also receive frequent updates on new technology, an annual directory of industry information, and many other valuable benefits available

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ISCET's main function is the direction and administration of the CET program, developed to measure the theoretical knowledge and technical proficiency of practicing technicians. Responsible industry executives recognize a technician with CET certification as one who possesses professional training, experience, and competence in his specialty area.

Since its creation in 1965 by the National Electronic Association, the CET program has been widely recognized by technicians, Government agencies, manufacturers, and consumers. Many electronics companies encourage their technicians to qualify for ISCET certification—and some even require it. Most technicians have proven their ability by earning the coveted ISCET certification.

Exam Fees. The fee for the CET exam is $50; that includes both the Associate exam and one Journeyman option. The fee for the Associate exam is $30. If the Journeyman option is taken separately from the Associate exam, the fee is $35. The fee for the 100-question CAT exam is $35. If a candidate fails any of these exams, the first retake is $15 (one test) or $25 (both tests), following a 60-day waiting period.

There is a different set of fees for the FCC exams, but the minimum fee is $25 for one session. The fee for Element 1 is $25, and the fee for Element 3 is $30. If the two examinations for the General Radio-telephone Operator's License are taken in a single session, the fee is

only $35. There are other combinations of elements and fees for the other elements.

Preparing For An Exam. The best way to prepare for any of these exams is to study the available background subject material. ISCET offers excellent, inexpensive study materials that will help all candidates prepare for each of its exams. If you are at the entry level, the Study Guide for the Associate CET Test will give you an excellent review for this first test. The 96-page booklet is priced at $10. The Software Study Guide and Practice Test with 300 sample questions is price at $39.95 plus $2 shipping. In addition, ISCET offers practice tests for most of the Journeyman options as well as excellent review texts on each of those options.

The FCC examinations are assembled from questions in a published question pool. By making the complete question pool available, the FCC has defined the limits of the basic knowledge that it expects each successful candidate to have. The availability of the pool also assures all persons taking the test that there will be no nasty surprises. A study guide and compete question pools for Elements 1, 3, and 8 is available for $29.95 plus $3 for shipping and handling costs. In addition, self-test computer software packages are available. Not surprisingly, being well prepared for all examinations can make the difference between passing and failing!

If, after reading this, you decide that you would like to take the CET CAT, or any of the FCC exams, contact one of ISCET's volunteer test administrators listed elsewhere in this article for details. As stated earlier, the exams are scheduled for the week of April 20 through April 26. For additional information, or to obtain an order form listing all of the available guidance and help materials, contact ISCET directly at 2708 West Berry St., Fort Worth, TX 76109; Tel: 817-921-9101, Fax; 817-921-3741.

See you at Testing Week 97, and on Electronics Technicians Day! Ω

MOD BOX

continued from page 49

Mod Box is in the Clean mode.

Adjust the Volume control to a comfortable sound level. Strum a few chords and notice that the sound is more or less unaltered. Now crank up the Low control and listen for the full rich boom of the bass notes. Turn it in the opposite direction, and observe how the low end is attenuated. Test the Mid and High controls in a similar manner. By the way, a boosted Mid is great for imitating the cheesy guitars of the early 1960s, while bumping the High gives a great edge to country-western solos.

Switch S1 to distorted, but be sure to watch the Volume control to keep from blowing out your loudspeakers! Dial up the Drive to see how the sound becomes increasingly more ragged. Low settings are perfect for rhythm guitar work, since the sound is quite similar to the creamy distortion of a tube amplifier. For piercing rock solos, spin the Drive control up to its highest setting and notice not only the increase in distortion but the long lasting sustain. And of course, you can further alter the effect by working over the Low, Mid and High controls.

In learning to play any musical instrument, practice is the name of the game. Even though the Mod Box only has 5 potentiometers and 1 switch, there are countless subtle (and not so subtle) effects possible. Experiment with the Mod Box and note the various settings you feel are most useful. After a while, you will probably find the Mod Box to be an indispensable part of your rig. It really can be a natural extension to just about any musical instrument. So what are you waiting for? Build the Mod Box today and see for yourself! Ω

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POCSAG DECODER

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errors is with the op-amp power taken from the RS-232 serial port TxD pin and DTR pin. Pin 7 on the 741 op-amp should read about +10 volts. Pin 4 on the op-amp should read about -10 volts. If either voltage reading is incorrect, check the polarity of D1-D4, C2, and C3.

An easy way to get a visual indication of the operation of the decoder board is with a RS-232 mini-tester, which uses red and green LEDs to indicate voltage polarity. The TxD LED should glow red (for -12 volts), the DTR LED should glow green (for +12 volts), and the CTS (or DSR) pin should flicker red and green to indicate a proper signal output to the computer. Also, as mentioned above, the software signal indicator will spin when data is being received on the proper serial port and pin. If a discriminator tap is being used, and everything else appears normal, but the program does not function or many errors are indicated by a low percentage of copy, try either removing R2 from the circuit, or replacing R2 with a jumper. Finally, make sure the software is correctly configured for the proper serial port and the proper data input pin (*i.e.* either CTS or DSR pin).

TABLE 1—COMMONLY USED POCSAG FREQUENCIES

152.03 - 152.24
152.51 - 152.84
158.10
158.70
454.025 - 454.650
931.0125 - 931.0875
931.8875, 931.9125, and 931.9375 are the national channels

Whether you buy the kit or build your own on perfboard, the interface is easy and inexpensive to build. The software is both well written and documented. The project provides an excellent hands-on education with POCSAG signals. But the best reason to try out this project is that it is just plain fun. Ω

Q & A

continued from page 9

lines, and because all available addresses are likely to be occupied by real memory. In fact, that's the main reason for distinguishing ports from memory addresses—it keeps them from conflicting.

If you're working with a bare 8088 rather than a PC, then instead of /IOR, /IOW, /MEMR, /MEMW, and AEN, you have just three control lines, /S0, /S1, and /S2. These are decoded as shown in Fig. 4. For example, instead of looking for AEN=1 and /IOR=0, an input port on this type of system looks for /S0=0, /S1=0, and /S2=1.

For more information about interfacing to 8088s and PC circuitry, see *The Art of Electronics*, by P. Horowitz and W. Hill (Cambridge University Press) and *The Personal Computer from the Inside Out*, by M. Sargent and R. L. Shoemaker (Addison-Wesley). Sargent and Shoemaker's earlier book, *The IBM PC from the Inside Out*, tells even more about the details of the 8088 but is now out of print; you may be able to find it in a library.

Poor Radio Reception

Q *I work in a hospital operating room and AM/FM radio reception is not very good. How can I improve this?—B. A., Winnipeg, Canada.*

A The poor reception may be deliberate—the operating room may be shielded to keep radio signals from interfering with delicate electronic equipment. Or it may just be the result of being deep within a steel-framed building. In either case, what you need is an outdoor antenna. Putting an antenna in an attic or near a window may suffice

CB Setup Queries

Q *I recently bought an omni-directional CB antenna for use on a tower. How would I set the SWR with this particular antenna? Also, how would I build a simple 12-volt, 15-ampere power supply for use with my CB?—T. J., Oklahoma City, OK.*

A If your antenna is properly designed for CB and fed with the specified cable impedance, the SWR will probably not need adjusting. Measure it, and if it's below 2:1, no adjustment is needed. Otherwise, try changing the length of the main vertical element to bring the SWR down. You can mount the antenna on a temporary support close to the ground while making preliminary checks and adjustments.

For power-supply schematics, see the *ARRL Handbook for Radio Amateurs*, published by the American Radio Relay League (Newington, CT 06111). Like CBers, hams use lots of 12-volt equipment, some of which draws lots of current, though I'm not sure if anything in that book will meet your stated current requirements. Incidentally, do you really need 15 amps? That's a lot more than a 4-watt CB transmitter should require.

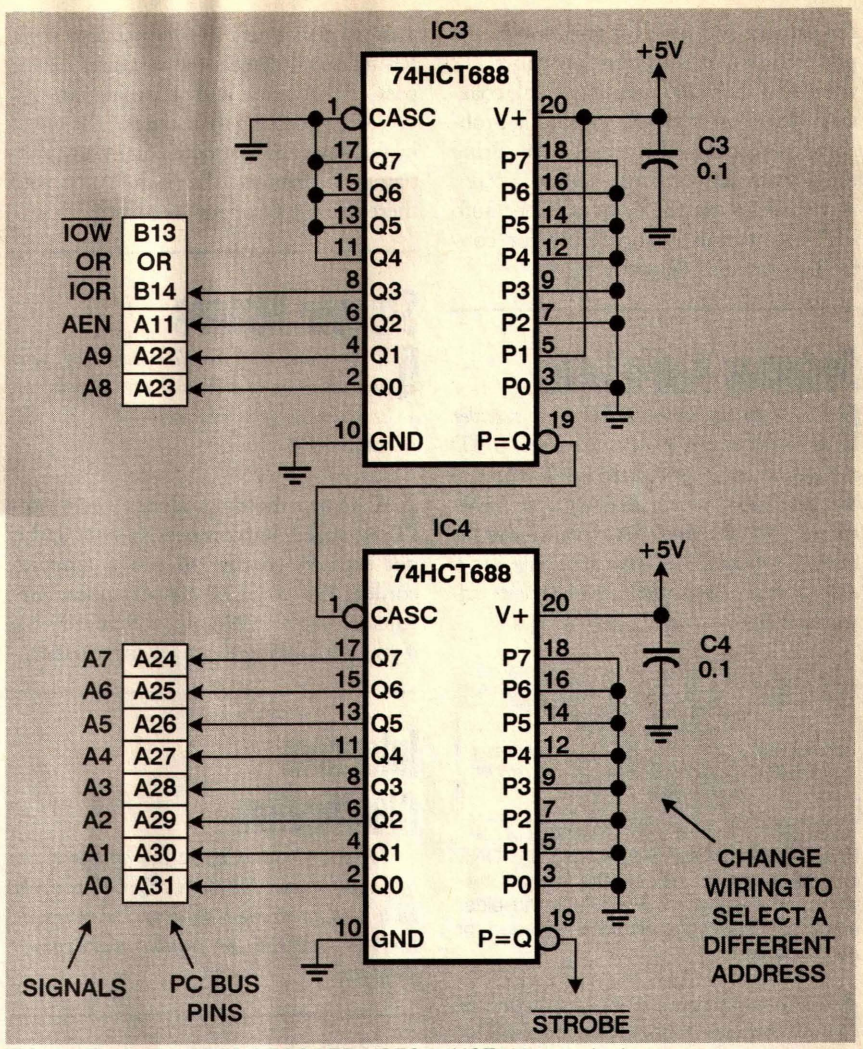


FIG. 3—THIS ADDRESS DECODER USES 74HCT688 magnitude comparators to recognize address 280(hex) when wired as shown.

CPU pin			Operation
S0	S1	S2	
0	0	0	Interrupt acknowledge
0	0	1	I/O port read (IOR)
0	1	0	I/O port write (IOW)
0	1	1	Halt
1	0	0	Memory read (MEMR), instruction
1	0	1	Memory read (MEMR), data
1	1	0	Memory write (MEMW)
1	1	1	Idle

FIG. 4—WHEN THERE IS NO BUS CONTROLLER, I/O devices must read the 8088's status pins directly. An Intel 8288, if present, translates those to I/O read, I/O write, and other signals.

Hacking A Video Camera

Q *Into my hands has fallen a small video camera from a security system. I would like to know how to hook it up so I can use it for closed-circuit TV or record with it, but I don't know anything about it. It has an 8-pin mini-DIN connector and another connector labeled "auto iris."—C. G. P., Isabela, Puerto Rico.*

A Discarded security cameras are interesting to experiment with. Open up

the camera and look for two things: the power supply connection (probably +12 volts) and the video output (a small coaxial cable). Power supply ground is probably connected to the cable shield. Bring these connections out, supply power, and you can use the camera. The "auto iris" connection is apparently for controlling the lens diaphragm.

Reducing Audio Level

Q *I have an old Sansui 5000 stereo receiver in perfect shape. I want to connect a CD changer to one of the input jacks. The CD changers have line out levels of 2 to 3 volts rms into 50,000 ohms. I'm afraid to plug one into the 150-mV Aux input of the receiver. Is there a circuit I can build to match the impedance and level?—M. M., Bothell, WA.*

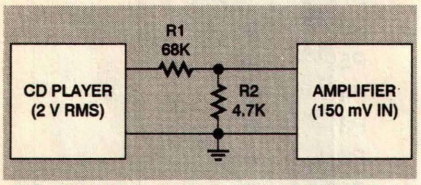


FIG. 5—AN "L" PAD SUCH AS THIS ONE can be used to reduce the signal level when connecting a CD player to an older amplifier. One circuit would be needed for each channel.

A Try just plugging it in—you won't do any damage, and it will probably work fine. CDs have a very high dynamic range, and 2 V rms is almost certainly the maximum, not the average, signal level. The average is probably quite close to 150 mV. Higher peaks will not damage the amplifier. If you find you still need to reduce the level, use the simple circuit shown in Fig. 5.

Anti-Theft Devices

Q *The drug store in my area uses an anti-theft device that is stuck to items that cost more than $5. If the security sticker is not disabled, it sets off an alarm when carried through the door of the store. How does this system work? I enclose one of the devices.—R. M., Methuen, MA.*

A Makers of security devices don't release much information about them, but here's our best guess: The device you enclosed is a resonant circuit. It's a rectangular white sticker about 1.5 by 2 inches, and inside it are a coil and capacitor made of flexible printed circuitry. A security device near the door emits a weak RF field and detects the resonant device passing through it and absorbing energy.

We're guessing that some of the metal in the device is magnetic, and demagnetizing it changes the inductance and therefore the resonant frequency.

Stepper Motors

Q *Is there any way I could control the speed and direction of a stepper motor to use on a tape recorder capstan?—C. K. S., Waymart, PA.*

A A stepper motor produces a very precise speed, but it moves in steps and is not smooth enough to run a tape recorder. We covered stepper motor circuits in August 1996, pp. 8-9 and 80-81, if you are looking for more information.

Intercom Clarification

Despite the caption on the diagram, the intercom in our February "Q&A" can't be built with an ordinary op-amp. It requires an LM380, LM386, or similar audio power amplifier.

Alternater Kit Found

In January 1996, a reader asked how to convert a 40-amp alternator (in an automobile) to deliver more amps. Conversion kits for doing this are sold by J. C. Whitney Co., PO Box 8410, Chicago, IL 60680. Thanks to Alan L. Olsen for this information.

Marine Radio Query

Q *I have a King Marine transceiver for which I need a few repair parts. The company (King Marine Radio Corporation, Clearwater, FL) can no longer be contacted. They made such fine products that I suspect they may have been taken over by another company. Can you, or one of your readers, tell me where I can get spare parts?—D. B. Hoisington, 5661 Davison Head Drive, Friday Harbor, WA 98250.*

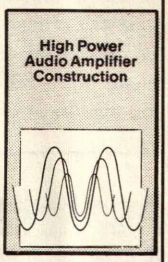
A We don't have the answer for this one, but you may be able to find out from Howard W. Sams and Co. (1-800-428-7267). They sell service manuals, and their catalog includes information about parts dealers.

The easiest way to get spare parts for older equipment is often to pick up another unit of the same type, perhaps broken, on the secondhand market. We're publishing your name and address so readers with information or parts to share can contact you directly.

Writing to Q&A

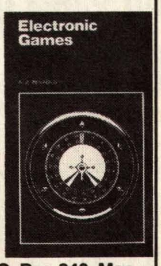
As always, we welcome your questions. The most interesting ones are answered in print, usually within 9 months. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. EN

HIGH POWER AUDIO AMPLIFIER CONSTRUCTION



BP277—Here's background and practical design information on high power audio amplifiers capable of 300±400 watts r.m.s. You'll find MOSFET and bipolar output transistors in inverting and non-inverting circuits. To order your copy send **$6.25 plus $3.00** for shipping in the U.S. and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** U.S. and Canada only. Payment in U.S. funds by US bank check or International Money Order. Please allow 6-8 weeks for delivery. MA03

ELECTRONIC GAMES



BP69—A number of interesting electronic game projects using IC's are presented. Includes 19 different projects ranging from a simple coin flipper, to a competitive reaction game, to electronic roulette, a combination lock game, a game timer and more. To order BP69 send **$8.00 (includes s&h)** in the US and Canada to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.** US funds only. Use US bank check or International Money Order. Allow 6-8 weeks for delivery. MA07

BY JEFF HOLTZMAN

OS/2, The On-Line World, Java, Delphi, and More

HERE'S A RIDDLE FOR YOU: WHAT KILLED OS/2? WELL, I DON'T KNOW THE PRECISE CAUSE, BUT THIS COULDN'T HAVE HELPED: A FLYER I RECEIVED FROM THE NEW RIDERS PUBLISHING DIVISION OF MACMILLAN COMPUTER PUBLISHING advertised a new reference book covering OS/2 Warp. At the top of the "personalized" letter it says, "Minimize your OS/2 Warp know-how and your value to your company this fast and easy way!"

I figure there are only three ways such a blunder could have occurred: 1) As the first known instance of a new type of virus, the PR virus; 2) As a plant by a disgruntled former IBM employee; 3) As a plant by a current employee of . . . what? What operating-system vendor gives a hoot about OS/2 any longer? Anyway, as it happens, I agree with the sentiment expressed. Getting involved with OS/2 is not a smart career move.

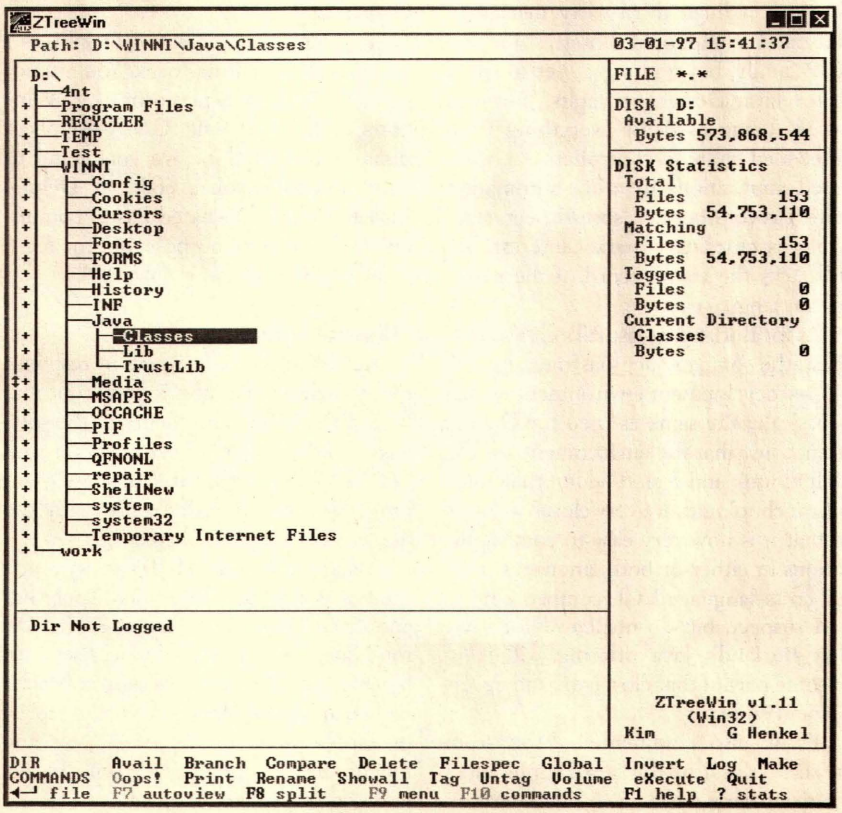


FIG. 1—A 32-BIT CLONE OF THE DOS CLASSIC Xtree, ZTree runs in a DOS box under Win95 or NT and provides 90% of the functionality of the original.

On-Line Experiences

Recently I cut my subscription to BIX, the on-line service of *Byte* magazine. It was a sad event, because for many years, BIX had been my main artery into the on-line technical world. But the web has overshadowed BIX, and other services are in danger as well. For example, CompuServe, at least in my opinion, has been on a downward spiral the past few years; I have mixed feelings about that. On one hand, if the company can't find anything to offer, then it deserves what it gets. On the other, in our mad rush to "web-ify" everything, I hope we remember that, as it is, the web cannot possibly serve every need.

In some ways, I see the web as a huge, disorganized factory-outlet mall. If you've got enough time and patience, you can probably find anything you want there. But if you're short on either, a more specialized offering may be appropriate. Ergo CompuServe, and perhaps the other "traditional" services, including Genie and AOL.

I came close to shutting down my CompuServe account, but held off for the time being for two reasons: 1) The quality of the information offered, and 2) The quality of physical connectivity.

CompuServe is neither as broad nor as deep as the web taken as a whole. But what's there is much more solid; it's mostly wheat and little chaff. The web is the opposite. Even with the help of semi-intelligent search engines (such as EchoSearch and WebCompass), there is much more wading through muck to find what you want.

As for physical connectivity, CompuServe recently added the PPP protocol, the same one used by most web browsers. If you're still running an old version of its access software, the proprietary system still works. But with the PPP setup, and version 3.0 or later of the access package, access is through PPP.

That's good for several reasons. First, it simplifies your system configuration, because you now dial through the operating system, instead of a proprietary tool. Second, to access software, one PPP-based provider looks like another. The advantage here is that if you have one of those $20 per month Internet Service Provider (ISP) accounts, you now have built-in redundancy. You can log in to CompuServe via your ISP; conversely, you can run your browser via the CompuServe dial-in connection. Third, the CompuServe dial-up in my area is more reliable and higher quality than the ISP I use. For example, I regularly connect via CompuServe at speeds above 30 kbps, and almost never below 28.8 kbps. On the other hand, the usual connect speed for my ISP is about 26 kbps, and it frequently drops down to about 21 kbps. It has never topped 28.8. Also, I seem to experience busy signals more often via my Internet Service Provider than with CompuServe.

The tradeoff, of course, is money. CompuServe still charges by the hour. However, when it comes to sending or receiving critical e-mail, I don't care about the charge. On the other hand, it makes no sense to browse or download large files on the CompuServe line, so there I use my ISP.

Bottom line: CompuServe, AOL, Genie, and BIX are all in trouble. But the web is not going to put them out of business. Instead, they are putting themselves out of business. They need to find new ways of marketing their strengths, which I see as reliable connectivity and quality of information.

I sincerely hope they do find ways to survive. I guess that I'm just not a mall shopper.

Java, Borland, and Delphi

Reader Frank Shinley sent me a news clipping from CNET. The article discussed the emerging importance of Java as a programming language. Frank wondered why the article did not mention Borland (maker of Delphi), and whether Borland even has a tool that supports Java.

I don't know why the article did not discuss Borland. Perhaps the author was ignorant or had an ax to grind. Regardless, Borland does have a significant Java tool under development; I wouldn't be surprised to see it released by the time this article reaches print. Borland is late with the product, compared with Microsoft, Symantec, and others. But if past performance is any indication, I would be very surprised if Latte (the product's code name) didn't blow all of the other solutions out of the bathtub and splatter them all over the walls.

It may be worth recounting a little history and background information. Java is a language that has been publicly released for less than two years. It was developed by Sun Microsystems originally for use in programming TV set-top boxes. It has been pushed mostly by a coalition of anti-Microsoft vendors, including Sun, Oracle, and Netscape, to name a few.

The language is like C and C++, except that it has no pointers. Internally, it is like Basic, in that it is a tokenized language that is interpreted at run time. It is very immature compared to languages like C/C++, Basic, and Pascal. There is a huge third-party market of class and component libraries for the CBP family, but nothing as yet to speak of for Java. Despite its faults, however, Java is being used for everything from embedded system controllers to web-based applications to office-automation suites (word processor, spreadsheet, etc.). It has extraordinary market interest, but still lacks the track record of the mainstream languages.

As for Borland, at last fall's COMDEX show, the company demonstrated its new C/C++ development environment, which is basically the same as used for Delphi. It's not just that the environment has the Delphi look and feel. The internal compiler technologies are very closely related, so that it is now very easy to code applications in either or both languages, with full cross-language VCL compatibility.

I suspect, but do not know for sure, that Borland's Java offering will soon become part of that closely bound development suite.

Frank also commented, "You seem especially fond of Borland Delphi and I am wondering why . . . ." That's hard to answer. I guess it is partly aesthetic, partly political, partly business, and partly technical.

I write code in everything from assembler to C to PostScript., but Pascal remains my favorite. I find that it has elegance lacking by all the others.

Another facet is that there are lots of C, C++, and Basic programmers around. Pascal programmers are harder to come by. In other words, there is a market niche. (Of course there is risk. If risk minimization is your chief motivator, stick with C or Basic.)

A further aspect is that Borland is not Microsoft. There are lots of Microsoft-focused developers (I even have Microsoft certification), but fewer Borland-focused ones. Again, it's a market niche situation.

Technically, I believe that Delphi is light years better than Visual Basic, and every bit as good as C/C++. In fact, I only know two things that C++ can do that Delphi cannot: operator overloading and multiple inheritance.

To be fair, support for the dominant Microsoft-based architecture (primarily OLE and COM) has been slow in coming. Nonetheless, it is possible in the current version of Delphi to build COM objects, and the upcoming Delphi 97 promises built-in support for ActiveX and other web-oriented mutations of OLE/COM.

The biggest weakness of Delphi, as I see it, is its Windows focus. You are not going to write cross-platform—*e.g.*, Windows, Macintosh, and UNIX—applications in Delphi. Nor are you going to write microcontroller code in Delphi. Borland sells DOS-based Pascal compilers for that type of purpose, but the focus is definitely on the Windows API.

NT and Apple

Reader Mark Levy wrote in response to my February column to point out that even if the kernels are identical, the software bundled with NT Workstation and NT Server are different, citing the Macintosh services included only with the Server version. He is correct.

Mark also stated that "It's pretty much a moot point, however, since Apple has announced that it is dropping Mac/OS for Next. I'm a long time PC user (not happily) and I recently bought a Mac. I had been contemplating converting all of my applications to the Mac. Not any longer. In my opinion, it's time to say good bye to Apple."

I responded that, regarding the purchase of Next by Apple, Apple is not

continued on page 73

BY DON LANCASTER

Evaluating Energy Claims, Color Systems, A New Current-Monitor IC, and More

THERE SURE HAVE BEEN SOME TOTALLY BIZARRE HAPPENINGS IN THE WORLD OF ALTERNATE ENERGY OF LATE. FOR EXAMPLE, IT APPEARS THAT A FEDERAL BUREAUCRAT NOTICED THAT A THIRTY-CENT VALVE MIGHT BE NEEDED TO KEEP A SOLAR hot water heater from freezing. To "solve" that "problem", a costly demo project was built up that instead used a solar panel to generate electricity and then used the current to *resistively* heat water! The end result of all that was replacing a 95% efficient low-tech system with a 6% efficient high-tech one, heating one *fifteenth* the water in the stupidest possible manner at many *hundreds* of times the cost!

That example is almost as bad as the time the Feds built up an adsorption solar cooler demo on a Southern school. It did not quite work well enough, so they attached a five ton evaporative precooler to the input. Then some killjoy asked "How big an evaporative cooler would they have needed *without* using their solar cooler in the first place?" The answer: Only *three* tons!

There's also been bunches of high-profile public seminars lately aimed at getting individual investors to help develop a low ΔT heat engine. Well, there once was this "been there and done that" person by the name of *Sadi Carnot* who once tried to build up an efficient heat engine. Sadly, old Sadi failed miserably. He only came up with a poor design. The best engine Carnot was able to create had an efficiency equal to the temperature differential divided by the absolute source temperature.

For instance, say you have a 125 degree hot well down your street. What is the best Carnot engine you could build on a 75 degree day? In absolute Rankine temperature, that's a 598 degree inlet temperature and a 50 degree ΔT. The best you can ever hope to do by using a "perfect" Carnot engine is a little over *eight* percent efficiency, and less than half that in the real world, at least on this particular hot well example.

Carnot had the audacity to call this poor performer an *ideal heat engine*. He even made it a law—known as the *Second Law of Thermodynamics*. The funny thing is that in the two centuries between us and Carnot, *every* attempt to repeal this law has failed! *Nobody*, but *nobody* has *ever* been able to build a better-than-ideal heat engine. In fact, *nobody* has *ever* been able to *match* Carnot's limited engine. The reason behind that is a real-world nasty known as *irreversibility*, and it's held true despite the countless thousands of tries and untold billions of research dollars blown to date.

So, I guess you might want to ask exactly what the seminar folks know that Carnot did not. After all, on any gamble, it pays to know the house odds.

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

Getting Yourself Energy Literate

Just how can you deal with "thuzzy finking" in the energy field? Your first step in *any* energy research project is to learn and understand all the basic laws of Thermodynamics. Start with the background tutorial information that can be found in HACK64.PDF on *www.tinaja.com* or in my *Hardware Hacker* reprints, then see if you can't get a copy of Sandfort's old but great *Heat Engines* in the old *Doubleday Science Series*. Give *Amazon Books* a try.

Next, learn some fundamentals of engineering economics. In particular, learn about such concepts as "payback time," which is why you worry about efficiency in the first place, followed by those all important "compared to what?" factors such as thirty-cent valves or hassle-free grid electricity at eight-cents per kilowatt hour. And always look for *elegant simplicity*. You can find more on this in HACK86.PDF and ELESIMP.PDF.

Introduction to Color Spaces

Any electromagnetic energy that has wavelengths between 400 and 800 nanometers is said to be in the "color band." We subjectively and arbitrarily call a single frequency radiation near 650 nanometers "red," a frequency that's near 530 nanometers "green," and a single frequency near 470 nanometers "blue." You can easily see those colors by taking the sun or another broadband light source and sending it through a dispersive glass prism, isolating the fully saturated rainbow colors into their typical "Roy G. Biv" pattern of red, orange, yellow, green, blue, indigo, and violet, as well as the colors in between.

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Hardware Hacker II, III or IV	$24.50
Micro Cookbook I	$19.50
PostScript Beginner Stuff	$29.50
PostScript Show and Tell	$29.50
Intro to PostScript Video	$29.50
PostScript Reference II	$34.50
PostScript Tutorial/Cookbook	$22.50
PostScript by Example	$32.50
Understanding PS Programming	$29.50
PostScript: A Visual Approach	$22.50
PostScript Program Design	$24.50
Thinking in PostScript	$22.50
LaserWriter Reference	$19.50
Type 1 Font Format	$16.50
Acrobat Reference	$24.50
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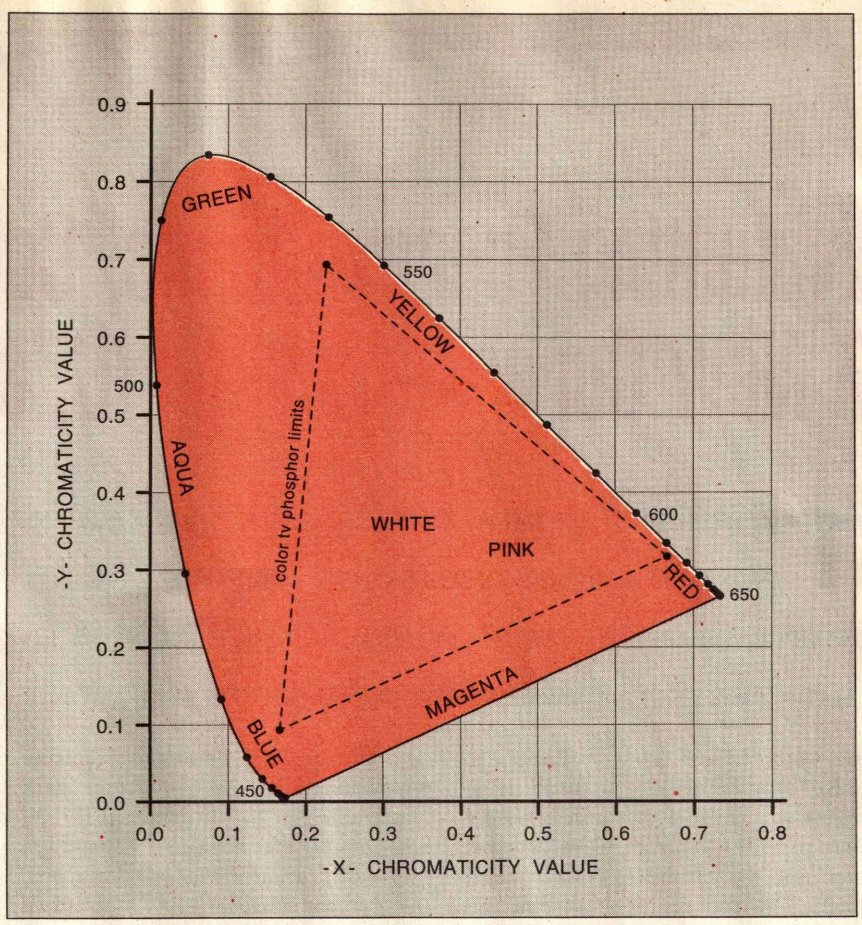


FIG. 1—THIS CIE CHROMATICITY DIAGRAM is one standard method of specifying all the perceived colors as a pair of x and y numeric values. Brightness extends out of the page. Outside numbers are saturated color wavelengths in nanometers. NTSC television is only able to show the colors inside the dashed triangle, but most color printing is much worse.

But where is magenta, salmon, ecru, or puce? It turns out that your eye can not resolve a point source of two or more colors at the same time. Instead, all multiple colors are blended into one "new" perceived color. Red and blue together give us *magenta*, a "false" color that does not show up in the spectrum. When you believe you are looking at magenta, you are really seeing a mixture that includes blue energy and red energy. The color "pink" is really nothing but a lot of red energy combined with lesser quantities of blue and green energy. "White" is a strong mix of all the available colors, all radiating or reflecting at once. To complicate matters, your eye is best at seeing green, so-so at seeing red, and poor at seeing blue, roughly in a 3:2:1 ratio. More on this can be found in MUSE95.PDF on www.tinaja.com.

Most perceived "colors" are really a mixture of color energies at various wavelengths. You might alternately view magenta as broadband energy that happens to be weak in the green. Thus, magenta "additively" equals red plus blue or "subtractively" can equal white minus green. When you start off with no energy or black and add colors, you have an additive color system.

One of many possible sets of additive color primaries is red, blue, and green. For instance, color TV selects red, blue, and green phosphors to build up the colors by adding energy. With additive colors, red plus green equals yellow.

If you start with lots of energy or white and remove colors, you have a subtractive color system. Example of that include mixing paint or printer's ink. One of many possible sets for the subtractive color primaries is cyan, magenta, and yellow, and another is red, yellow, and blue. With the subtractive colors, blue plus yellow equals green.

In order to try and sort all of this out, in 1931 a standards group called the CIE created the "standard observer chromaticity diagram" shown in Fig. 1. Although it might look a little bizarre, it is basically a blob of the gamut of all perceivable colors in an *x-y* space. Specifying

an x and y will uniquely determine any color, real or imagined. Pure spectral colors go clockwise around the top edge of the blob. The "shortcut" across the bottom handles the saturated fake colors you get by mixing varying amounts of red and blue. White is near the blob center, while pastels lie further off axis.

The dashed triangle within the blob shows all the NTSC colors you can get using the three normal RGB TV phosphors. As you can see, color TV can only give you "some" of the color gamut. PAL television is more limited. And typical triple primary printing or dye systems are even worse yet. However, the latest of premium five and six color printing concepts replace the triangle with a larger pentagon or a hexagon and can reproduce nearly all possible colors.

Color Space Conventions

There are times and places where you will want to standardize colors. But your useful rules will obviously be different for ink on paper, for a phosphor on screen, for additive in food, or for a dye on textile. Thus, there are many different methods to specify any particular color. Each of these methods might be called a "color space convention." Each has advantages and disadvantages for its intended use. But since a color is a color, there are precise transforms that let you move from one color space to another. Several popular color-space conventions are listed in Fig. 2. Let's summarize them here:

CIE Color—Uses the convention of Fig. 1, with the brightness being how high above the x-y plot you are. Three *tristimulus* constants set your maximum "white point." Their ratios set the color and brightness.

RGB Color—Specifies how much red energy, how much green energy, and how much blue energy is needed for a given color and brightness.

RGBA Color—A variation on RGB color that adds a fourth channel or variable. That extra channel sets the "transparency" of an overlay or allows matte or bluescreen keying between two video sources.

Grayscale "Color"—A single value monochrome gray for a given color. One popular formula is gray = 0.59 green + 0.30 red + 0.11 blue.

HSB Color—An acronym for Hue, Saturation, and Brightness. The hue can be the angular position around a saturated color wheel. The saturation is how much white gets added to the hue. The brightness ends up as the total generated or reflected energy.

YIQ Color—A variation on HSB used by NTSC color. The "Y" is the monochrome brightness. The "I" is a shifted in-phase component of the difference between the white and the selected color. That "Q" is a shifted quadrature component that sets the difference between white and your selected color. Together, I and Q set a vector whose amplitude sets the saturation and whose angle sets the hue of the desired color.

YUV Color—A newer variation on HSB used by PAL, VCR, and digital video. "Y" is again the monochrome brightness. "U" and "V" are paired quadrature color difference channels setting hue and saturation.

CMY Color—The subtractive print shop primaries of cyan, magenta, and yellow. These are the stock inks used in full-color printing.

CMYK Color—A fourth or "black" press run added to your print-shop primaries. Applied as an additional process color to produce solid blacks and im-

CIE COLOR–
Measures how much of three "perfect" *tristimulus* colors are needed. Either as *xyz* or *xy* and a white reference.

RGB Color–
Specifies how much energy from each of three standard red, blue, and green tv phosphors is needed for a given color.

RGBA Color–
Adds a fourth channel to RGB color. This new channel has production and editing uses that can include transparency or keying.

GRAYSCALE "COLOR"–
The single gray equivalent for a given color, adjusted for best visual perception. 0.59 green + 0.30 red + 0.11 blue in RGB color space.

HSB COLOR–
Three independent values specify the *hue* (or shade), the *saturation* (or purity), and the *brightness* (or luminance).

YIQ COLOR–
Broadcast tv variation on HSB. Brightness is a b/w luminance channel. A subcarrier hue sets phase; while its amplitude sets saturation.

YUV COLOR–
VCR and PAL variation on HSB having better fidelty. Brightness is a b/w luminance channel. Subcarrier hue sets phase; amplitude sets saturation.

CMY COLOR–
Standard printer's additive primaries of cyan, magenta, and yellow. Used extensively for three ink process color printing.

CMYK COLOR–
Adds black overprint to additive CMY color. Normally used to improve color printing, especially for black text. Requires fourth pass.

HEXCHROME COLOR–
Premium system adds orange and green to additive CMYK color. Gives exceptional color rendition, but demands six precise printing passes.

MUNSEL COLOR–
A series of standard "paint chips". Often used for soil analysis and related scientific studies. Its popularity is waning.

PANTONE COLOR–
A series of standard "ink chips". Pretty much an industry standard, especially for printing, textile, and graphic arts.

TRUEMATCH COLOR–
An electronic equivalent to Pantone or Munsel that gives exact matching of video monitor colors and color prepress.

FIG. 2—POPULAR COLOR-SPACE CONVENTIONS are summarized in this listing.

BATTERY-RELATED RESOURCES

AMP
PO Box 3608
Harrisburg, PA 17105
(800) 522-6752

Analog Devices
PO Box 9106
Norwood, MA 02062
(617) 329-4700

Battery Technology
5700 Bandini Blvd
Commerce, CA 90040
(800) 982-8284

Benchmarq
2611 Westgrove Dr #101
Carrollton, TX 75006
(214) 407-0011

Electronic Comp News
1 Chilton Way
Radnor, PA 19089
(215) 964-4345

Electronic Products
645 Stewart Ave
Garden City, NY 11530
(516) 227-1300

Maxim
120 San Gabriel Dr
Sunnyvale, CA 94086
(800) 998-8800

Measurement & Control
2994 W Liberty Ave
Pittsburgh, PA 15216
(412) 343-9666

Motorola
5005 E McDowell Rd
Phoenix, AZ 85008
(800) 521-6274

Power Express
14388 Union Ave
San Jose, CA 95124
(800) BATTERY

Sensors
174 Concord St
Peterborough, NH 03458
(603) 924-9631

Unitrode
7 Continental Blvd
Merrimack, NH 03054
(603) 424-8610

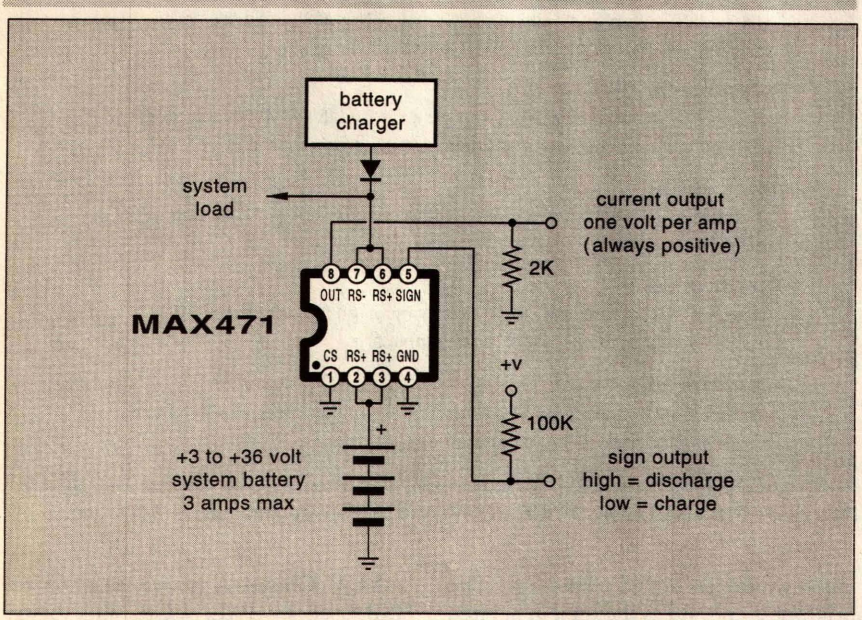


FIG. 3—THE MAXIM MAX471 is a high-side current sensing integrated circuit intended for use in battery "gas gauge" applications.

proved legibility in premium printed material.

Munsel Color—An older series of standardized and numbered "paint chips" used in soil analysis, textile, and paint industries.

Pantone Color—A similar series of fully standardized and numbered "ink chips" used by printing and graphic arts industries.

Truematch Color—This one is an electronic equivalent to the Munsel and Pantone systems that is useful for accurate video color displays.

You can not accurately show a CIE chromaticity diagram on any color monitor, or on any normal printed page. But I have made up a fair to middling approximation to one and put it in MUSE111.PDF on www.tinaja.com, though I did cheat a little and brightened the center. Unmodified in a "true" display, the same quantity of energy (0.33) that you'll need for a solid red, blue, or green in the corners gives you a rather dark monochrome gray in the middle.

Actually, you might think of the "real" chromaticity diagram as a huge stack of flat layers. The bottom layer is flat black overall. The higher you go, the brighter your color. A corner might range from, say, bright red to black. The middle goes from white on the top, gray in the middle, and black on the bottom.

One place to get the fundamental CIE color information is in the McGraw-Hill's *Television Engineering Handbook*. Color spaces and their transforms are easily explored with the general purpose PostScript language. Full details are in their *Red Book*, which is otherwise known as the *PostScript Reference Manual*, and available per my nearby *Synergetics* ad.

A Great Video Read

I just received a review copy of the second edition of Keith Jack's *Video Demystified*, published by HighText. That fat volume is chock full of the insider details on most of the popular video formats, compression schemes, MPEG, JPEG, scrambling information, digital processing, encoding and decoding, video conferencing, and lots more.

Among its many useful features, *Video Demystified* explains digital 4-2-2 video in all its gory details. Like digital RGB (and sometimes called 4-4-4), 4-2-2 has three separate component channels. And similar to YUV, 4-2-2 uses a luminance channel and a pair of chroma channels.

One major difference between the component RGB and 4-2-2 video is that the 4-2-2 colors get sampled only one-half as often as the luminance. Put another way, pairs of pixels share the same color values. Not a big deal since the eye is worse at seeing color changes than brightness changes, but it (usually) requires only 16 bits per pixel instead of 24.

Specifically, 4-2-2 luminance is sampled at a 13.5-MHz rate for 720 pixels per normal resolution active line, while both chrominance channels are sampled at a 6.75-MHz rate for 360 pixel pairs per line. And, as you might predict, 4-1-1 video is a somewhat lower consumer-grade option where the color information is sampled only one quarter as often as the luminance. It needs only 12 video bits per pixel.

Actually, the digital 4-1-1 video is

"good enough" for nearly everything except possibly editing and post production where generation losses, round-off errors, and the compression artifacts rear their ugly heads. The 4-1-1 quality differences often seem negligible even to a critical viewer, especially when they are viewed on a normal television set.

An Analog Current Monitor

Those folks at Maxim sure have come up with a unique new chip in their MAX471. They call this gem, shown in Fig. 3, a "high side current sensing IC." While the intended use is to simplify "battery fuel gauges" in portable electronics, the chip can do a lot more.

The usual way to measure current is to sense the voltage drop across a small shunt resistor that is in series with your load. In the case of battery systems, you'll often want to do this on the high side (usually the positive terminal) of your battery. In addition to other reasons, that allows the battery and its charger to share the same common ground connection.

Here's how the chip works: Your battery voltage can be anything from 3 to 36 volts. There is an internal 36-milliohm shunt resistor. One end of the shunt goes to the battery. The other end goes to your charger and load. There are two chip outputs. One is a sign output, which shows you whether your battery is presently charging or discharging. It does that by telling you which way your current is going through the shunt. The second output is a current output. Typically, that current output gets connected to a 2K load resistor to ground. It outputs a ground-based analog signal of one volt per ampere of sensed current.

The chip kind of acts as a "full wave rectifier" in that the output current is always positive going with respect to ground. That happens regardless of the current direction. The amplitude of the current appears on pin 8, while the charge-discharge sign of the current appears on pin 5, thus avoiding any system need for negative voltages.

To build a battery gauge similar to a gas gauge, you'll send those two signals on to further analog or digital processing. That further processing typically calculates ampere hours in versus ampere hours out, and then relates charge and discharge totals to the actual battery properties. Note that amperes multiplied by time will equal ampere hours. The process of summing things against time is called integration. Analog op-amps or digital accumulators are great at that sort of thing.

Your maximum sensed current is 3 amps. You could connect two chips in parallel for 6-amp service. Supply current is 60 microamps when active and five when the shutdown pin is brought high. An extra 36 milliwatts of power is consumed by the shunt when sensing a 1-amp load. That loss is usually well under 1% of your total battery capacity, and is comparable to other wiring losses.

Note also that the sign output is open collector. An external pull-up resistor must always be provided. There is also a MAX472 chip that lets you use your own shunt and gain resistors.

One good method to build a cheap shunt is to use a narrow part of a printed circuit trace. A second is to use a segment of paper clip. Both of those ploys need calibration and are somewhat temperature sensitive.

I can think of a dozen other uses for either device, which I have summarized in Fig. 4. I have also shown several other sources of battery related ICs and information as this month's resource sidebar.

Names and Numbers

First up this month is a new databook on *Low Voltage Logic* IC families from *Texas Instruments*. Next, from *Rohm*, is a *Short Form Catalog* on unusual and underutilized integrated circuits and sensors. From *Unitrode*, comes a similar *Product Selection Guide*. And *International Rectifier* weighs in with a *Power Solutions* product digest.

Also this month, from *Microchip*, comes the PIC12C5XX data book on their baby PICs. Speaking of which, *FBASIC TICkit* is a new series of PIC projects and software offered by *Versa Tech Electronics*. Included are a compiler, debugger, console, and launcher.

NAMES AND NUMBERS

Amazon Books
Box 80387
Seattle, WA 98108
(800) 201-7575

Aura Systems
2335 Alaska Ave
El Segundo, CA 90245
(310) 643-5300

Automotive Industries
PO Box 2056
Radnor, PA 19080
(215) 964-4876

The Bone Room
1569 Solano Avenue
Berkeley, CA 94707
(510) 526-5252

Hewlett-Packard
PO Box 10301
Palo Alto CA 94303
(415) 857-1501

HighText Publications
PO Box 1489
Solana Beach, CA 92075
(619) 793-4141

International Rectifier
233 Kansas St
El Segundo, CA 90245
(310) 322-3331

Lindsay Publications
PO Box 538
Bradley, IL 60915
(815) 935-5353

Microchip Technology
2355 W Chandler Blvd
Chandler, AZ 85224
(602) 786-7200

Moments in Time
330 State Rd 101
Amherst, NH 03031
(603) 673-3633

Pantone
590 Commerce Blvd
Carlstadt, NJ 07072
(201) 935-5500

Rohm Corporation
2150 Commerce Drive
San Jose CA 95131
(408) 433-2225

Synergetics
Box 809
Thatcher, AZ 85552
(520) 428-4073

Texas Instruments
PO Box 809066
Dallas, TX 75380
(800) 336-5236

Thomson Industries
2 Channel Drive
Port Washington, NY 11050
(800) 554-8466

Versa Tech Electronics
PO Box 18476
Boulder, CO 80308
(303) 440-5590

BATTERY FUEL GAUGE–
Use analog or digital techniques to integrate current versus time to get amp hours in versus amp hours out. Relate to battery characteristics.

SOLAR ENERGY MONITOR–
Place in series with solar panel to monitor the incoming solar radiation and the total watt hours of energy recovered.

HEADLIGHT TESTER–
Use threshold logic on current levels to determine "open", "short", or "normal" headlight current consumption.

LOUDSPEAKER PROTECTOR–
Monitor floating speaker outputs and shut down anytime output currents approach a dange level.

CHARGE LIFE EXTENDER–
Can you get more total energy and life out of a battery by continuously pulse recycling a fraction of the discharge energy?

DATA MULTIPLEXER–
Send both power and data over the same line by changing the load current for a one or zero. Sense the current change as data.

ELECTRONIC CIRCUIT BREAKER–
Monitor load currents and then provide a shutdown or foldback any time the drawn current goes over or under set limits.

FLASHLIGHT BULB SAVER–
Prevent turn-on lamp surges or set your overall brightness by sensing and then limiting the total delivered lamp current.

CURRENT HISTORY LOGGER–
Use the current output to record long term current history for industrial processes, replacing a chart recorder.

SHORT FINDER–
Isolate circuit board and integrated circuit short circuits by applying and monitoring safe test current levels.

BATTERY OVERCHARGE DETECTOR–
Prevent overcharging or fault currents by monitoring charging current and total charge time. Shut down on excess.

CABLE TESTER–
By creative use of binary weighted resistive loads, multiple cable lines can be tested simultaneously.

LOAD RELAY–
By sensing the current in one system, a second can be turned on or off. Such as autopowering a monitor only when computer is active.

FIG. 4—THERE ARE MANY interesting and innovative uses for the MAX 471. A baker's dozen of them are summarized here.

Incredibly innovative automotive developments are now offered on a custom basis from *Aura Systems*. Those include a combination head gasket and triple spark plug that greatly improves your flame front; their electromechanical direct valve scheme; plus a combo flywheel, starter, and alternator. One source of information on similar firms is *Automotive Industries* magazine.

"Flutterwumpers" and related X-Y table surplus bargains are stocked in depth by *Moments in Time*.

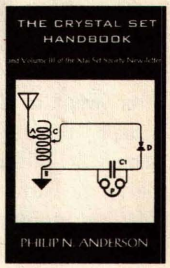
If there aren't enough skeletons in your closet, contact *The Bone Room* for immediate assistance. They have a free catalog.

Also free is a video on *Nyliner* bearings from *Thomson Industries*. Another free video and a pair of demo/tutorial CDs on the superb 5SiMX PostScript printer is available from *Hewlett Packard*.

For the fundamentals of starting up your own tech venture, check out my *Incredible Secret Money Machine II*. Autographed copies available singly or as part of my bargain *Lancaster Classics Library* as per my nearby *Synergetics* ad.

I've also just reorganized parts of my *www.tinaja.com* Web site. Newly included are gateway access to *PIC*, *Electronic Engineering*, *PostScript*, *Pseudoscience*, and *Webmastering* Internet sites, along with scads of technical and non-technical favorites and a new library shelf on wavelets. As usual, most of these mentioned resources show up in the Names and Numbers or in the Battery-Related Resources sidebar. Be sure to check those out first before you visit my *www.tinaja.com* Web site or call our US technical helpline. EN

INSIDE CRYSTAL SETS



An easy-to-read book on crystal set theory and construction opens vistas for novices and pros alike. Build radios like Grandpa did, do it better, and know what you are doing. *The Crystal Set Handbook*, published by The Crystal Set Society, is an authentic guide on the topic.

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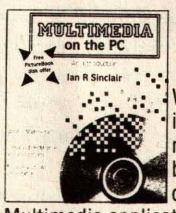

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BY FRANKLIN J. MILLER

Disney and the HP-200B

JUST ABOUT EVERYONE HAS HEARD OF THE WALT DISNEY COMPANY AND HEWLETT-PACKARD. BUT DO YOU KNOW HOW THOSE FAMOUS COMPANIES ARE RELATED TO EACH OTHER, AND TO AUDIO TESTING? OK, I WON'T KEEP YOU IN SUSPENSE:

Hewlett-Packard developed the world famous HP-200B audio oscillator, and the Walt Disney Company used it in the movie *Fantasia*. The story about how that all came about is fascinating; let me share it with you.

A Little History

The story starts in Germany in 1891 when Max Wein developed a circuit for AC bridge measurements. He published his works in *Ann. Der Phys.*, Vol. 44, 1891, p 704-7. The document was titled "*Measung der induction constanten mid dern Optischen Telephon.*" Unfortunately, in 1891 there were no amplifying devices, so, at that time, it was impossible to make the circuit oscillate.

By 1908, Dr. Lee DeForest's triode took care of that problem, but one more element was needed to make an oscillator perform properly. That was feedback. The Wein-type oscillator uses both negative and positive feedback as described by Harold S. Black. Black attempted to patent the concept of negative feedback in 1928, but the U.S. Patent Office turned him down. He wrote articles on the subject, including one called "Stabilized Feedback Amplifiers," in the 1930s. Others also wrote about feedback during that time period.

In 1938 William R. Hewlett wrote his MS thesis on "A New Type Resistance-Capacity Oscillator," which was published in 1939 in *Degreed Engineer*. Then, along with partner David Packard, he built the audio oscillator shown in Fig. 1.

The original circuit was built with tubes and used a light bulb as the stabilizing element. The circuit used both negative and positive feedback to achieve the desired results. The tuning range of 100:1 was achieved by the dual tuning capacitor, which was popular at that time. The oscillator worked well, and the process of selling them began.

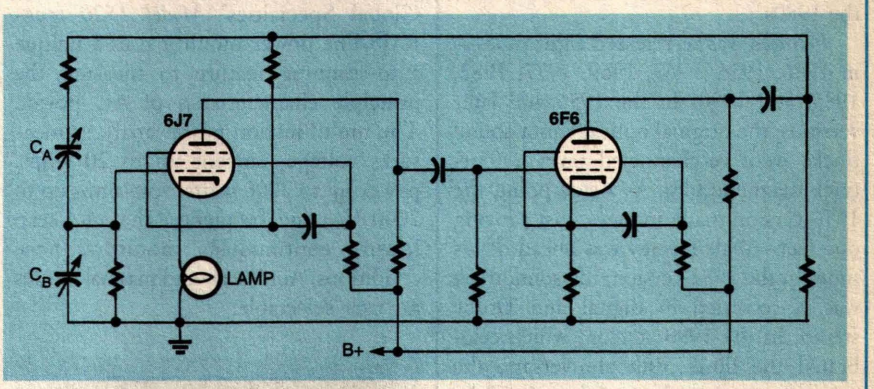

FIG. 1—HEWLETT'S ORIGINAL OSCILLATOR circuit. Note the dual tuning capacitors and the lamp, which was used as the stabilizing element.

You might wonder how Hewlett-Packard became known to the Disney organization. The story goes that a terrific oscillator was shown at the 1938 IRE (now IEEE) convention. William Stancil who was a sound man for MGM had left his job there to work at home in his garage laboratory. One of Stancil's friends, George Downs, heard about the new oscillator. Downs had drawn a picture of the audio oscillator and suggested that Stancil get in touch with Norm Neely. Neely was to become the sales agent for Hewlett-Packard. Another person came into the picture at this point. His name was Johnny Hawkins, a Disney engineering consultant working on a new movie, *Fantasia*. Stancil went to work for Neely as a sales engineer; he then helped to sell the audio oscillator to Hawkins at Disney, and the rest is history.

Fanta-sound

Fantasia premiered on November 13, 1940, at New York's Broadway Theater, one of only 12 theaters in the world specially equipped to run it with an expensive 56-speaker "Fanta-sound" system. Fanta-sound was the effort of three people that worked for Disney—Hawkins, William E. Garity, and H. M. Tremaine. The system consisted of three program tracks and one control sound track on a single optical film. The control track consisted of several different frequencies, which controlled the opening and closing of the amplifier systems relative to the action on the screen. Eight Model HP-200B audio oscillators were used to test the various channels, recording

equipment, and speaker systems in the theaters that showed the film.

There were three loudspeaker systems used. One was behind-the-screen. It was a three-horn system instead of the usual single horn. There was a second system on the side walls, and the third was positioned at the rear of the auditorium, to create the illusion of the sound moving with the action on the screen.

The two major manufacturers of sound equipment for theaters at that time were Western Electric and RCA. Systems were simple compared to today's standard. The audio track was optical, which meant that the frequency response was limited to ±5 dB at 40 Hz to -10 dB at 10kHz. It was thought at the time that to extend the frequency response any higher would be pointless, as most people would not be able to hear those frequencies. Another problem was that increasing the frequency response of the film past 6500 Hz would cause noise generated by the optical track. Although noise reduction was available, it was not as sophisticated as today's modern systems. The film took two years to produce and cost $2.3 million dollars, a huge expense for that time.

Unfortunately, the film lost money, and it closed in 1941. The Fanta-sound system was never used again, although Disney used the HP-200B oscillators into the 1980s.

Fantasia was re-released eight times—in 1946, 1956, 1963, 1969, 1977, 1982, 1985, and 1990. In the 1956 and later versions, the original optical Fanta-sound tracks were re-channeled onto a four-track magnetic film. As a side point, the 1956 version made money—just proving one fact—Walt Disney was ahead of his time. In the 1982 version, the soundtrack was re-recorded in digital and Dolby stereo. In the 1990 version, which celebrated the film's 50th anniversary, the original sound track was "de-noised" by the Disney engineers to remove the pops, scratches and hisses. EN

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continued from page 24

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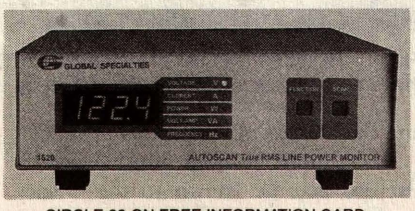

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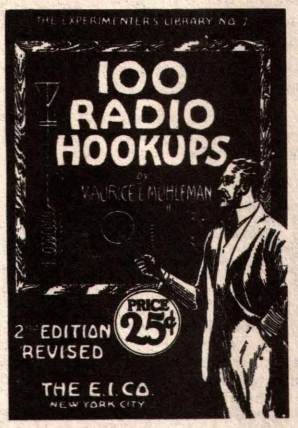

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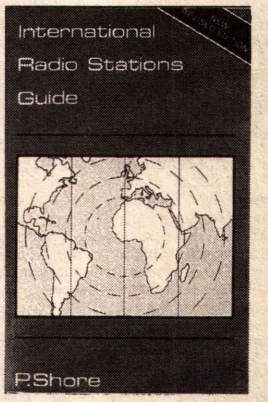

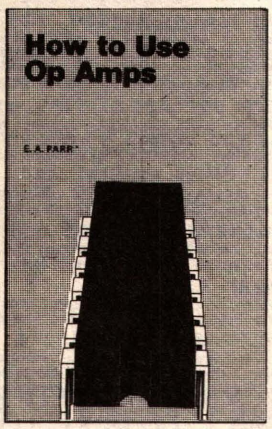

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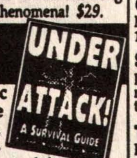

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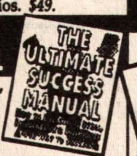

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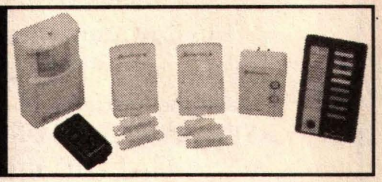

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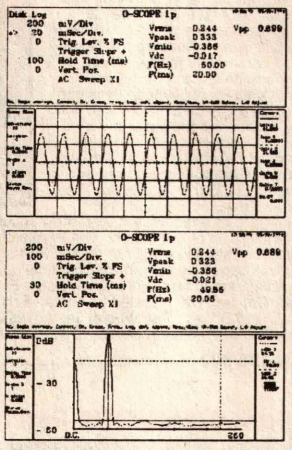

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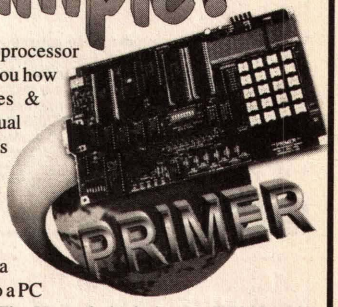

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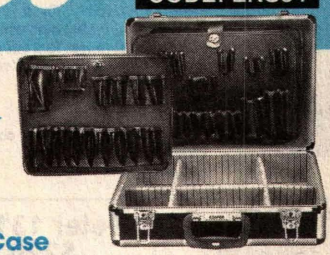

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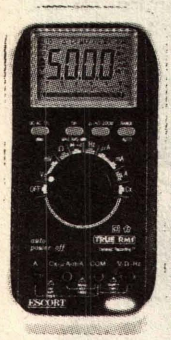

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Measure AC volt to 20kHz
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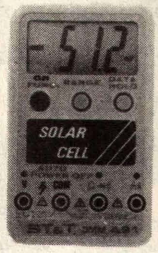

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Inductance: 10mH-10,000H
Capacitance:10nF-10mF
Resistance:10Ω-10MΩ
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Statistics, tolerance,
Best for design, incoming testing & production
SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

Inductance: 200uH-200H
Capacitance: 200pF-20,000uF
Resistance: 2Ω-20MΩ
Resolution of 0.1uF, 0.1pF, and 1mΩ are useful for high frequency and SMD
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics
Best for high frequency RF
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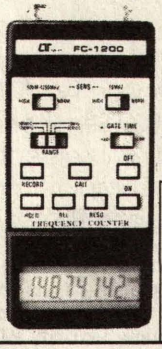

Frequency Counter FC-1200 $129.95

Frequency:10Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
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Also Available:
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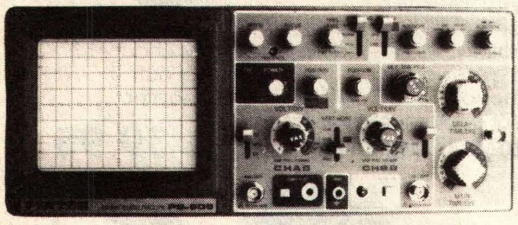

20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200	20 MHz DUAL TRACE	$339.95
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PS-405	40 MHz DELAY SWEEP	$569.95
PS-605	60 MHz DELAY SWEEP	$769.95
PS-1000	100 MHz DUAL TRACE	$999.95

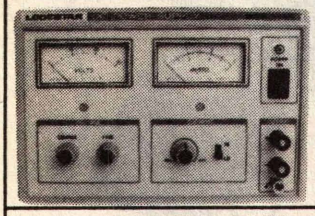
Scope Probe: 60MHz x1, x10 $15, 100MHz x1, x10 $22
250MHz x1, x10 $29, 250MHz x100 $39

Digital Storage Scope

DS-303 30MHz, 20M Sample/sec $849.95

DS-303P w/ RS-232 Interface $1,049.95

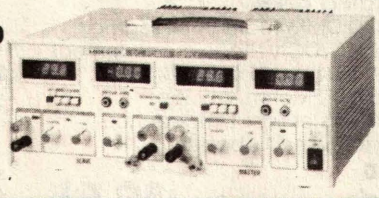
Switchable between digital and analog modes
2 K word per channel storage
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter control



DC Power Supply PS-303 $159.00

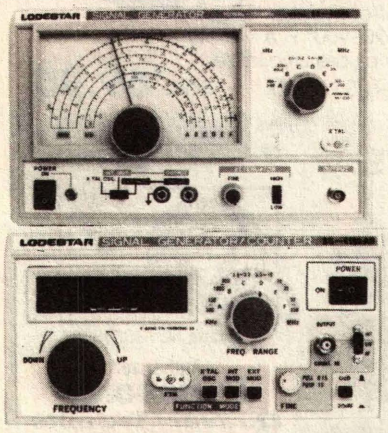
0-30 VDC , 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF Signal Generator SG-4160B $124.95

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz
AM modulation
Audio output 1 kHz, 1 Vrms
Output Impedance: 50 Ohm
Size: 5.9"H x 9.8"W x 8.1"D

RF Signal Generator Counter SG-4162AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

Audio Generator AG-2601A $124.95

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

Audio Generator/Counter AG-2603AD $229.95

Generates audio signal same as AG- 2601A
6 digit frequency counter 10Hz-150MHz for internal and external sources Sensitivity <50mV

Function Generator FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine/square/triangle/pulse/ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control freq. to 1000:1

Function Gen./Counter FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

Sweep Function Gen./Counter $329.95

0.5Hz to 5 MHz in 7 ranges
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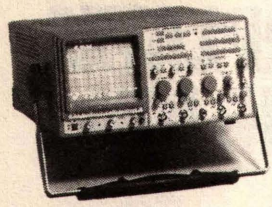
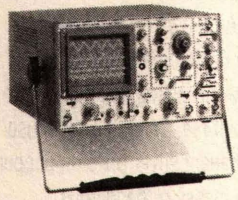
100 MHz Cursor Readout Scope 4 ch, 8 traces OS-6101 $1,499.95



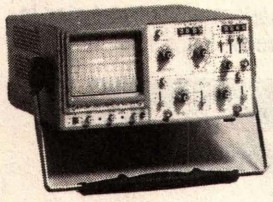
* 4 independent channels, 8 traces
* Time /Voltage cursor measurement
* ALT triggering function for 4 ch.
* Sweeps to 2ns/div, Delayed Sweep
* TV Sync., Ch. 1 output, Z-axis input
* 2 probes(x1, x10)

100 MHz Scope, 4ch. 8 traces Best value all purpose scope OS-6100B $1,329.95



* 4 channels, 8 traces
* High sensitivity 500μV/div
* Sweeps to 2ns/div, Delayed sweep
* 20 kV accelerating voltage
* TV sync., Z-axis input
* A and B gate output
* Best price 100 MHz scope
* 2 probes(x1, x10)

50 MHz Triggering Oscilloscope OS-653 $699.95



* Dual Channel
* Hold Off Function
* Delayed Sweep
* Built-in Delay Line
* TV Sync
* ALT Triggering
* High sensitivity 1 mV/div
* Trigger level lock function
* Z-axis input, CH1 output
* 2 probes(x1, x10)

20 MHz Oscilloscope OS-622B $344.95

* Dual trace, X-Y operation
* TV Sync., Z-axis input,CH 1 output
* High sensitivity 1 mV/div
* Trigger level lock
* 2 probes (x1, x10)

OS-623B - 20 MHz w/Delayed Sweep.....$ 449.95
OS-935 - 5 MHz One channel.....$ 209.95

DC Linear Power Supplies Single Output

* Constant voltage and constant current mode
* Voltage regulation ≤0.01%
* Current regulation ≤0.2%
* Low ripple and noise
* Overload and reverse polarity protection
* Features 2 analog or 1 digital meter(PS series) 2 analog or 2 digital meters(PR series)

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PS-1830D : Digital Display.....$219.95
PS-1850 : (0-18V, 0-5A).....$219.95
PS-1850D : Digital Display.....$244.95
PS-3030 : (0-30V, 0-3A).....$224.95
PS-3030D : Digital display.....$254.95
PS-6010 : (0-60V, 0-1A).....$209.95

PR-1810H : (0-18V, 0-10A).....$349.95
PR-3060 : (0-30V, 0-6A).....$314.95
PR-6030 : (0-60V, 0-3A).....$314.95
PR-6030D : Digital Display.....$399.95

Triple Output DC Power Supplies

* Two variable 0-30VDC, 0-3A outputs
* One fixed 5VDC, 3A output
* Auto tracking
* Auto serial and parallel operation
* Constant voltage and constant current mode
* Continuous/dynamic load can be selected
* Features 4 analog or 2 digital displays

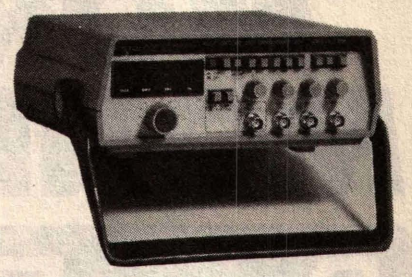
PC-3030 : (0-30V, 0-3Ax2).....$499.95
PC-3030D : Digital display.....$549.95

Programmable DC Power Supplies

* High stability , low drift, 4 digit display
* Front/rear output-sense switch selectable
* Auto step running w/timer settings
* 100 point programmability (PPS series)
* 50 point programmability (PPT series)
* Auto serial and parallel operation (PPT series)
* Auto tracking (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G: (0-18V, 0-6A).....$1099.95
PPS-3635G: (0-36V, 0-3.5A).....$1099.95
PPS-6020G: (0-60V, 0-2A).....$1099.95
PPT-1830G: (0-18V, 0-3Ax2, 0-6V, 0-5A).....$1399.95
PPT-3615G: (0-36V, 0-1.5Ax2, 0-6V, 0-3A).....$1399.95

Digital Display Function Generator FG-8016G $239.95



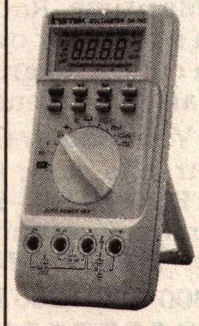
* Frequency Range: 0.02Hz to 2MHz
* Three Instruments in one: Function generator, Pulse generator & Frequency counter.
* Sine, Triangle, Square, TTL Pulse and CMOS output
* Built-in 6 digit counter with INT/EXT function
* 1000:1 tuning range
* Variable DC offset control

FG-8015 Function Generator
* 0.02Hz-2MHz (No Counter).....$189.95
FC-8131 Intelligent Counter 1.3GHz.....$469.95
FC-8270 Intelligent Counter 2.7GHz.....$629.95
UC-2010G Universal Counter.....$294.95

Digital Multimeter & C Meter DM-8034(3½ digits) $179.95

* 8 Function, AC/DC voltage, AC/DC current, resistance
* Built-in C meter, diode test and audible continuity check
* High voltage 1000V and 20A range
* 0.5% basic accuracy

DM-8040 (3¾ Digits, True RMS)
* Measures ACV to 50 kHz.....$339.95
DM-8055 (5½ Digits).....$649.95
* 0.006% basic accuracy
* 1μV, 1mΩ, 1nA resolution
* dBm measurement
* Auto range, relative mode, Max/Min
DM-8055G(5½ Digits, GPIB).....$889.95



Model DM-392 (3¾ digits) $109.95

* Auto/Manual ranging(38 ranges)
* 42 Segment analog bar graph
* Data Hold/Min-Max memory /Relative mode
* Auto power off
* Overload protection
* Audible continuity check /diode test
* Capacitance: 1pF-40μF
* Frequency: 0.1Hz-1MHz
* 20 Amp range
* Double high energy fused (1A, 20A)
* 0.3% DCV accuracy

DM-351 : 3½ Digits w/Continuity, Auto Off.....$54.95
DM-352 : 3½ Digits, Cap. Freq. hFE, 20 Amp.....$79.95
DM-353 : 3½ Digits, Cap. Freq. Temp. hFE.....$84.95
DM-391 : 3¾ Digits, Auto, Cap. Freq. Min/Max.....$99.95
DM-392 : 3¾ Digits, Hold, Min/Max 20Amp.....$109.95
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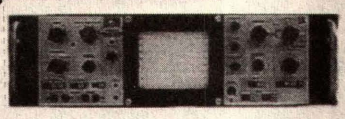

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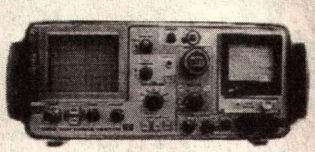

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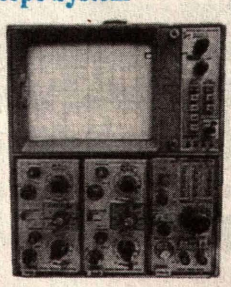

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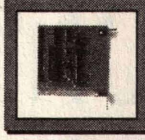
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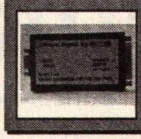
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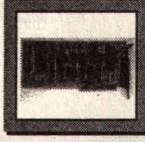
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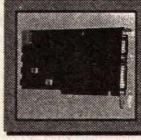
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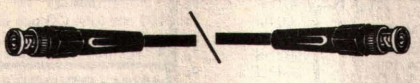

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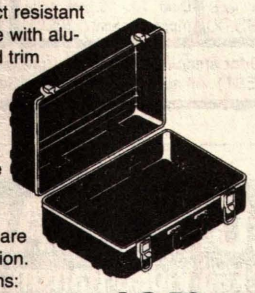

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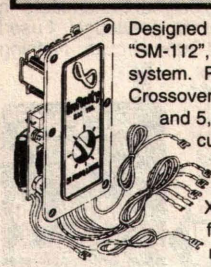

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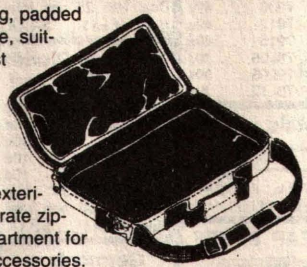

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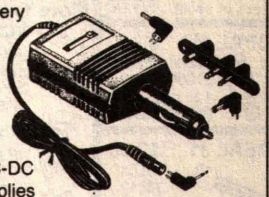

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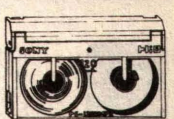

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Deal L6: 30 pcs total, (10pcs of ea.).....$2.50

SOLDER ROLL
SN63/37
.031" dia
1 Lb Roll
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$10.00 minimum order. We accept VISA, MC, MO, Check, No-CODs. Please add $5.00 for shipping & handling (foreign addresses: $8.50). Florida addresses add your applicable county sales tax. Hours: Mon-Fri: 9AM to 5PM (EST). All new premium parts. Send for free Catalog.

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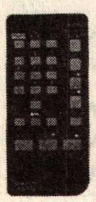
CONVERTERS:	20	50	100+
Regal CR-83	45	39	35
* New, Panasonic TZPC 145	75	69	65
DQN-5 (2 or 3) (unmodified)	45	39	35
DRZ-3 PJ (unmodified) 70 Channel Plain	35	32	29
DRX-3 PJ (unmodified) 60 Channel Plain	32	30	27

Call for FREE catalog.
405-631-5153



REMOTE CONTROL HAND UNITS:	20	50	100+
Jerrold Replaces: 400/450/550	4.95	4.50	4.25
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Panasonic: Call for model #	7.50	7.00	6.50
Zenith: All	4.95	4.50	4.25
Tocom: 5503-VIP, 5503-A	7.00	6.50	6.25
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Call for Oak, Hamlin, Regal-83, Regency, Texscan, and all others.

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Bit Driver Handle $4.00

We carry most remote hand units. If you don't find the one you're looking for, we can locate for you.
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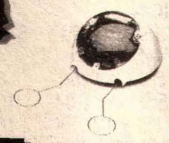

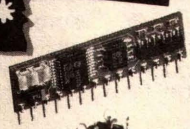

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Rubber Boot Included

Our Best Offer Ever on a High Quality Full Sized DMM

General

Display: 3-1/2 Digit LCD, 21mm Figure Height with Automatic Polarity
Overrange Indication: 3 Least Significant Digits Blank
Temperature for Guaranteed Accuracy: 23°C±5°C RH<75%
Temperature Ranges:
Operating: 0°C to 40°C (32°F to 104°F)
Storage: -10°C to 50°C (14°F to 122°F)
Power: 9V Alkaline or Carbon-Zinc Battery(NEDA1604)
Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	±(1%rdg+2dgts)
2000mV	1mV	
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	±(1.2%rdg+2dgts)
2000µA	1µA	
20mA	10µA	
200mA	100µA	
10A	10mA	±(1.2%rdg+2dgts)

Overload Protection: mA Input. 2A/250V fuse.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding. Calibrated in rms of a Sine Wave.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	±(1.2%rdg+2dgts)
2000Ω	1Ω	
20KΩ	10Ω	
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test
Measures transistor hFE.

$19.00 any qty

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Switchable Scope Probe Sets

(Selectable X1/Ref/X10) These high quality scope probe sets are for oscilloscopes up to 60MHz (model HP 9060) or 150MHz (model HP9150). Both sets include a handy storage pouch and include an IC test-hook adapter for the probe. The BNC connector rotates to avoid cable tangle or kink. Cable length is 1.4 meters.

CAT NO	DESCRIPTION	PRICE EACH 1	10	100
HP-9060	Scope Probe Set DC~60MHz	$16.49	$14.49	$11.58
HP-9150	Scope Probe SetDC~150MHz	24.95	21.95	18.62

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12" *NEW!*	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12" *NEW!*	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12" *NEW!*	22.09	18.35	14.68

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

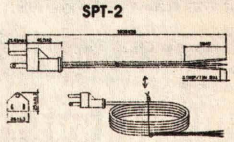
REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

AC Power Cords

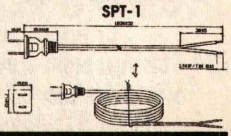
Our power supply cords are economical and practical for OEM and replacement applications. We stock 6' lengths, with the open end conveniently stripped and tinned (5mm).

SPT-2



CAT NO	SIZE	TYPE	RATING @ 125V (A)	LENGTH (ft)	COLOR	TEMP
SPT-1BLACK	18/2	SPT-1	10	6	Black	60°
SPT-1GRAY	18/2	SPT-1	10	6	Gray	60°
SPT-2BLACK	18/3	SPT-2	10	6	Black	60°

SPT-1



CAT NO	PRICE EACH 1	10	100	500
SPT-1BLACK	$ .88	$ .57	$ .51	$ .46
SPT-1GRAY	.92	.61	.55	.49
SPT-2BLACK	1.97	1.21	1.07	.97

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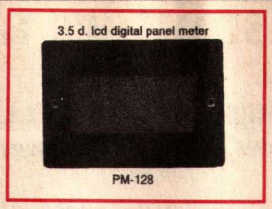
CIRCLE 327 ON FREE INFORMATION CARD

Digital Panel Meters (LCD & LED)

Don't let the prices fool you. These digital panel meters are not surplus, so even if you design them into an ongoing manufactured product, you can be assured of continued availability. These high quality digital panel meters are decimal point selectable with guaranteed zero reading at zero volts input.



Applications Include:

- Voltmeter
- Thermometer
- pH Meter
- dB Meter
- Watt Meter
- Current Meter
- Capacitance Meter
- LUX Meter
- LCR Meter
- Other Industrial & Domestic Uses

PM-128: 3-1/2D LCD Digital Panel Meter

PM-129: 3-1/2D LED Digital Panel Meter

Features

- 200mV Full Scale Input Sensitivity
- PM-128 - Single 9VDC Operation
- PM-129 - Single 9VDC Operation
- Decimal Point Selectable
- PM-128 - 13mm Figure Height
- Automatic Polarity Indication
- Guaranteed Zero Reading for 0 Volt Input
- High Input Impedance (>100Mohm)

Specifications - PM-128/PM-129

Maximum Input	: 199.9mV DC
Maximum Display	: 1999 counts (3-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: PM-128 - LCD Display PM-129 - LED Display
Measuring Method	: Dual-Slope Integration A/D Converter System
Overrange Indication	: "1" Shown in the Display
Reading Rate Time	: 2-3 Readings per sec.
Input Impedance	: >100 Mohm
Accuracy	: +-0.5% (23+-5°C, <80% RH)
Power Dissipation	: PM-128 - 1mA DC PM-129 - 60mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: PM-128 - 9V DC PM-129 - 9V DC
Size	: 67mm x 44mm

3-1/2 Digit LCD 3-1/2 Digit LED 4-1/2 Digit LCD

PM-328: 4-1/2D LCD Digital Panel Meter

Features

- 200.00mV Full Scale Input Sensitivity
- Single 9V DC Operation
- Decimal Point Selectable
- 11mm LCD Figure Height
- Automatic Polarity Indication
- Low Battery Detection and Indication
- High Input Impedance (>100 Mohm)

Specifications - PM-328

Maximum Input	: 199.99mV DC
Maximum Display	: 19999 counts (4-1/2 Digits) w/Automatic Polarity Indication
Indication Method	: LCD Display
Overrange Indication	: "1" Shown in the Display
Input Impedance	: >100 Mohm
Accuracy	: +-0.05% (23+-5°C, <80% RH)
Power Dissipation	: 1mA DC
Decimal Point	: Selectable w/Wire Jumper
Supply Voltage	: 9V DC
Size	: 67mm x 44mm

AS LOW AS $5.25 ea.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

INDUSTRY BEST PRICING!

CAT NO	PRICE EACH 1	10	25	100
CSD 4010-12	$ 9.88	$ 6.38	$5.48	$4.87
CSD 6025-12	9.38	5.91	5.41	4.71
CSD 8025-12	8.88	5.85	5.19	4.49
CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE ($INCH-H_2O$)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

Tired of Paying Inflated Prices for Solder?

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
RH60-1	1-lb. Spool, .031", 60/40	$ 6.90	$ 5.96	$ 5.30
RH63-1	1-lb. Spool, .031", 63/37	6.95	6.10	5.41
RH60-4	4.4-lb. Spool, .031", 60/40	24.00	21.90	17.92
RH60-TUBE	6-oz. Tube, .031", 60/40	.99	.89	.79

CCD Camera - IR Responsive

As Low As $85!!

This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.

Power Supply Regulating Kit for CA-H34

This simple kit is designed to fit onto the back of the CA-H34 CCD camera. It resolves the problem of hooking up the camera to an UNREGULATED supply (which damages the camera) by providing safe regulated power from any 12V-14V DC supply. It also provides regulated 12V DC from a 12V AC source.

CAT NO	DESCRIPTION	PRICE EACH 1	5
CA-H34A	PCB Mounted IRCCD Camera	$99.00	$85.00
A34	Power Supply Regulating Kit	$6.95	-----

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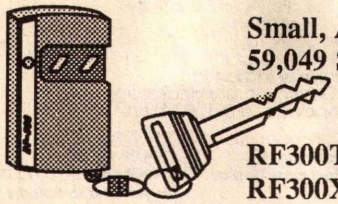
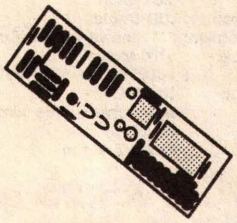
Miniature Transmitters and Receivers



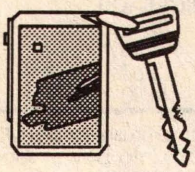
Small, Attractive, High End Quality, 2 Channel 318 MHz Transmitter
59,049 Settable Codes, 120'–300' Range, 1–1/4" x 2" x 9/16", Assembled

		Qty	1	5	10
RF300T	150' Range Transmitter		24.95	19.95	15.95
RF300XT	300' Range Transmitter		29.95	24.95	19.95



Small, High End Quality, 2 Channel Receiver for the RF300 Transmitters
1–1/4" x 3–3/4" x 9/16" PCB w/ .1" spaced pads for standard connectors
Input: 8–24 vdc Output: Gated CMOS Momentary and Latching Lines

		Qty	1	5	10
RF300R	Receiver, Fully Assembled		24.95	20.95	16.95
RF300RK	Receiver, Complete Parts Kit		19.95	15.95	12.95
RF300PA	Pre–Amplifier. Doubles Range		14.95	11.95	9.95



Small, Economical, Single Channel Transmitter and Receiver Set
Set Code, 60' Range, 1–7/8"x2–3/8"x7/16" (T), 2"x2–3/4"x9/16" (R)
Receiver Input: 5 vdc Output: Gated TTL Momentary Line

		Qty	1	5	10
RF60	Transmitter and Receiver Set		24.95	19.95	14.95

Add $ 4 shipping for first item + $ 1 for each additional item. Ca. residents add 8.25% tax
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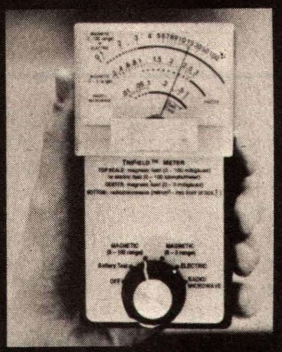

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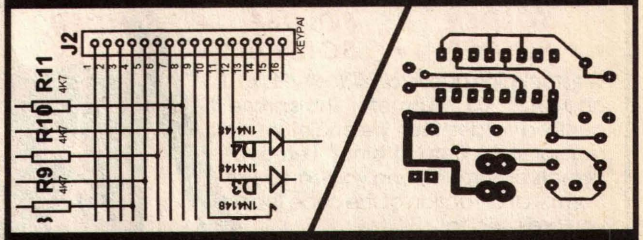

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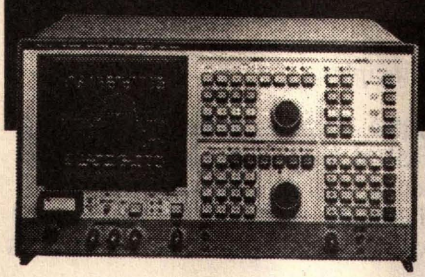

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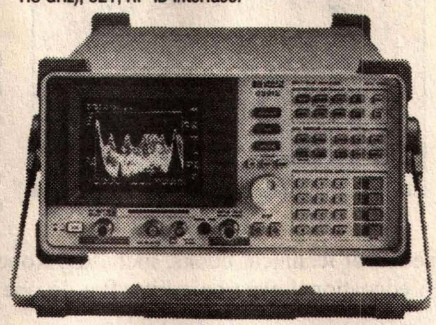

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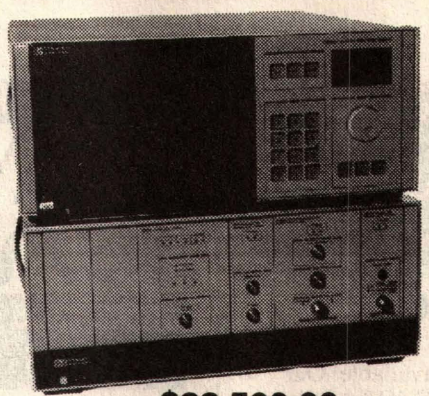

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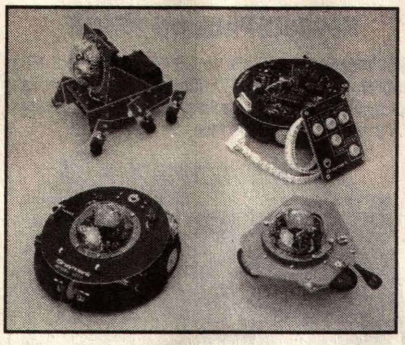

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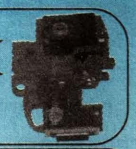

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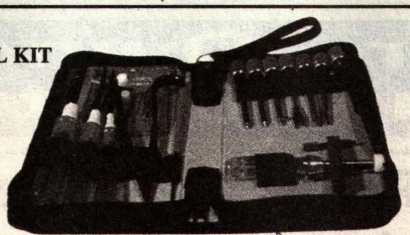

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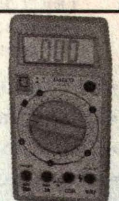

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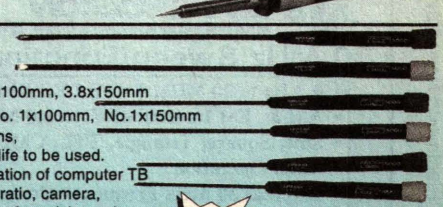

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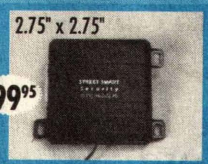

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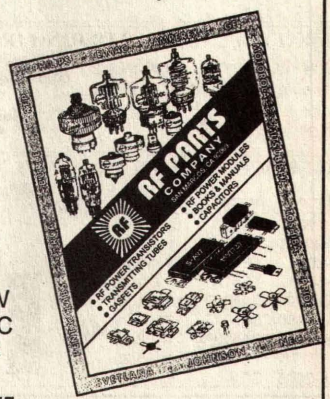

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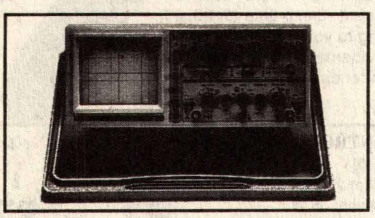

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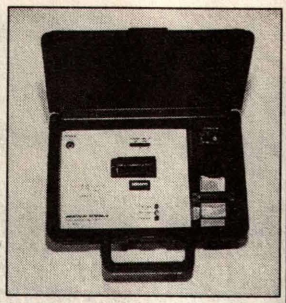

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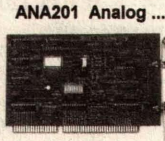

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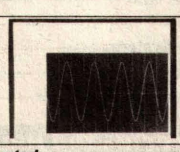

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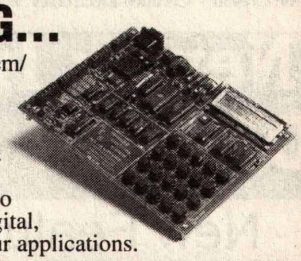

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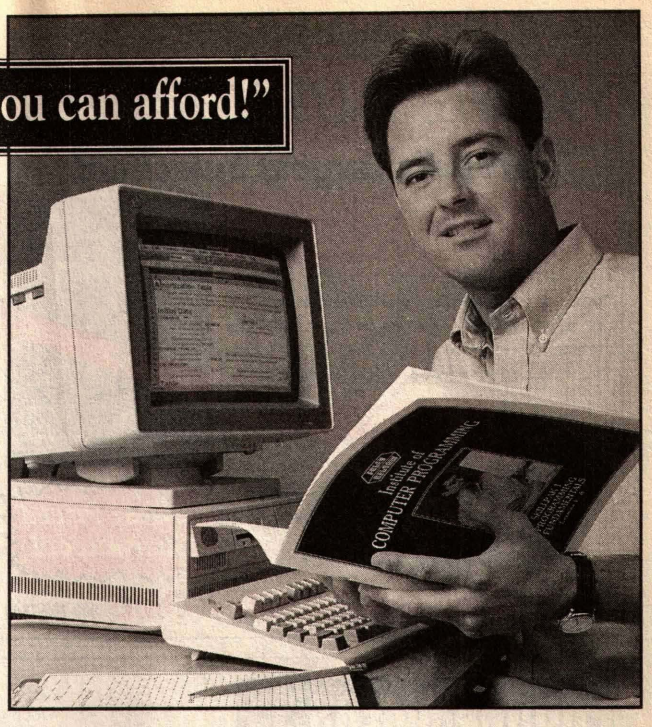

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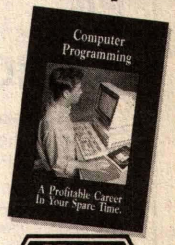

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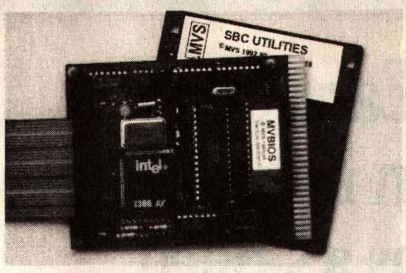

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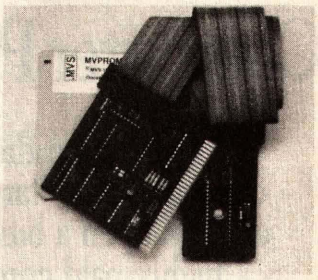

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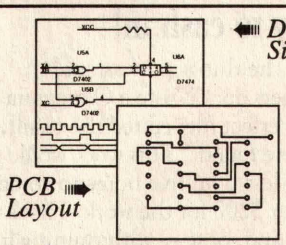

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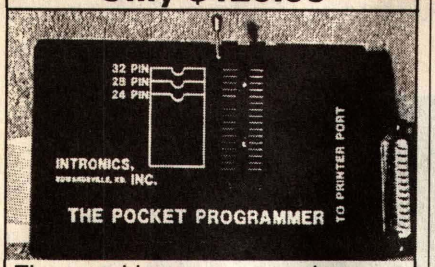

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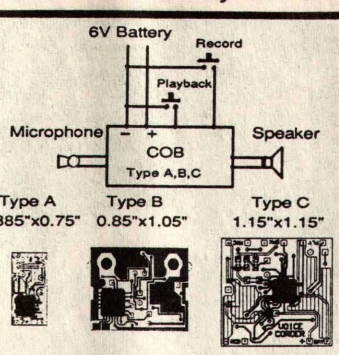

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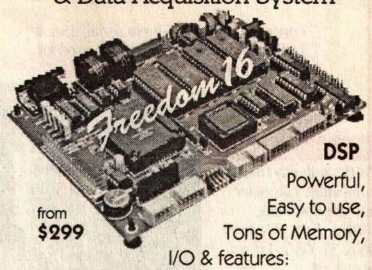

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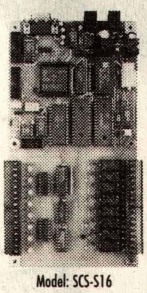

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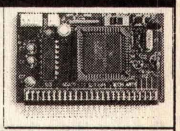

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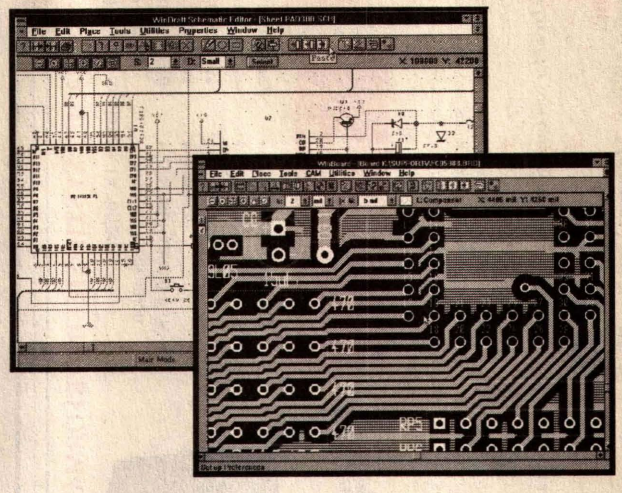

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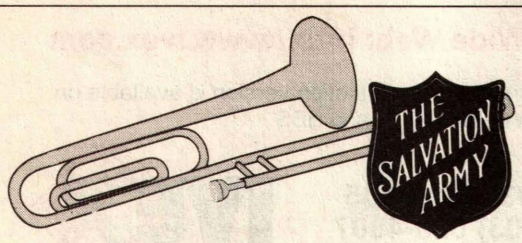
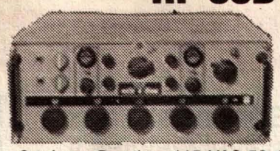


HF SSB RECEIVER



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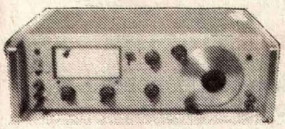

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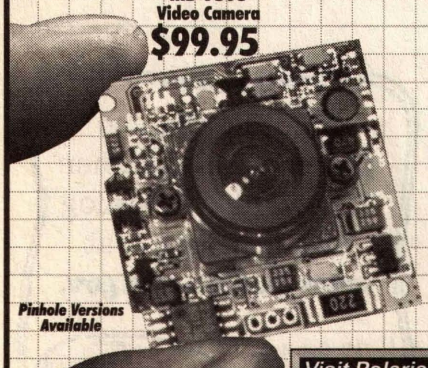

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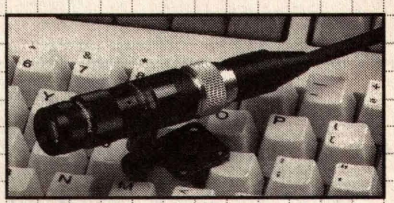

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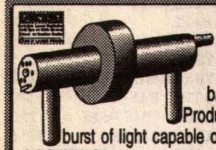

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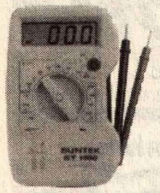

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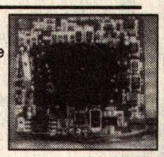

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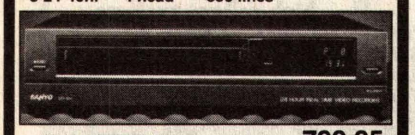

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TEK 7S14 1 GHZ SAMPLING PLUG IN	$350.00	TEK 7904 500 MHZ MAIN FRAME	$250.00
TEK 453 50MHZ OSCILLOSCOPE	$200.00	TEK 7104 1GHZ FRAME WITH-	$2750.00
TEK 485 350 MHZ PORTABLE SCOPE	$600.00	(7A29,7A29,7B10,7B15)	
KEITHLEY 480 PICOAMMETER	$300.00	GENRAD 1657 RLC BRIDGE	$750.00
TEK 608 MONITOR	$650.00	TEK 577 D1/177 CURVE TRACER	$1500.00
TEK DAS9100 WITH PROBES	$750.00	TEK 7D20 PROGRAMABLE DIGITZER	$500.00
KIKUSUI 5020 20 MHZ OSCILLOSCOPE	$180.00	TEK 465 100 MHZ OSCILLOSCOPE	$400.00
PHILLIPS PM3212 25 MHZ OSCILLOSCOPE	$200.00	TEK 465B 100 MHZ OSCILLOSCOPE	$450.00
TEK 422 15 MHZ OSCILLOSCOPE	$150.00	TEK 2335 100 MHZ OSCILLOSCOPE	$1200.00
TEK 455 50 MHZ OSCILLOSCOPE	$250.00	TEK 834 DATA COMMUNICATION TESTER	$130.00
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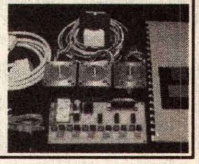

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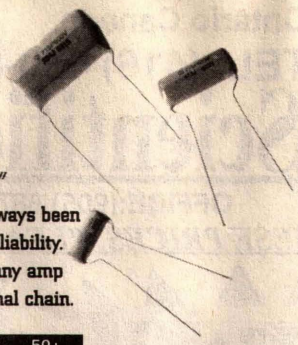
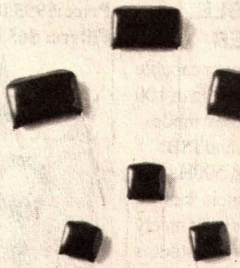
CAPACITORS



SPRAGUE "ORANGE DROPS"

Sprague polypropylene capacitors have always been famous for their great performance and reliability. Significantly improve the performance of any amp by upgrading to "Orange Drops" in the signal chain.

	1	10	25	50+
.001UF/600V	$.45	.36	.32	.29
.0015UF/600V	.46	.36	.32	.29
.0022UF/600V	.47	.37	.33	.30
.0033UF/600V	.48	.37	.34	.30
.0047UF/600V	.49	.38	.34	.31
.01UF/600V	.50	.45	.40	.35
.015UF/600V	.65	.50	.42	.38
.022UF/600V	.68	.55	.46	.39
.047UF/600V	.80	.65	.59	.52
.068UF/600V	.95	.80	.74	.69
.1UF/600V	1.05	.92	.83	.74
.15UF/600V	1.40	1.25	1.05	.95
.22UF/600V	1.90	1.55	1.35	1.24
.47UF/400V	1.85	1.50	1.30	1.20



XICON CAPACITORS

Metalized Polypropylene. Made in JAPAN. A very high quality cost effective range of coupling capacitors. Great sound, small size.

	1	10	25	50+
.001UF/630V	$.30	.24	.20	.17
.0022UF/630V	.30	.24	.20	.17
.0047UF/630V	.30	.24	.20	.17
.01UF/630V	.30	.24	.20	.17
.022UF/630V	.35	.26	.22	.19
.047UF/630V	.42	.36	.30	.26
.1UF/630V	.46	.40	.34	.30
.22UF/630V	.63	.56	.45	.40
.47UF/630V	1.20	1.00	.88	.79

TRANSOHM - SCREEN GRID RESISTORS

	10	25	50	100+
470 OHM / 1 WATT	$.10	.08	.07	.06
1K OHM / 5 WATT	.32	.25	.22	.19

SPRAGUE "ATOM" ELECTROLYTICS

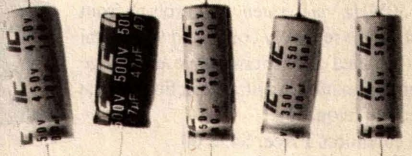
These electrolytics have been the standard in most vintage amps...and there's a good reason!

	1	10	25	50+
8UF/450V	$2.25	1.95	1.85	1.68
10UF/150V	1.20	1.05	.90	.82
10UF/500V	3.50	2.90	2.60	2.25
16UF/475V	3.60	2.95	2.65	2.35
20UF/500V	3.70	3.40	2.80	2.55
20UF/600V	6.70	6.20	5.90	5.65
25UF/25V	.80	.75	.70	.65
25UF/50V	.85	.79	.73	.69
40UF/500V	4.95	4.35	3.80	3.15
50UF/50V	.90	.83	.77	.73
80UF/450V	5.50	4.80	4.20	3.70
100UF/100V	1.75	1.55	1.35	1.30
100UF/350V	4.45	4.05	3.65	3.25
100UF/450V	6.90	6.10	5.50	4.70
250UF/25V	1.25	1.10	.95	.85

ILLINOIS ELECTROLYTICS

Excellent replacement electrolytic capacitors for general purpose applications requiring tight ripple control. Axial leads, made in Japan.

	1	10	25	50+
22UF/500V	$2.80	2.25	1.95	1.72
47UF/500V	4.75	3.80	3.35	3.20
80UF/450V	3.50	2.95	2.60	2.40
100UF/350V	2.80	2.30	2.10	1.95
100UF/450V	3.90	3.25	2.95	2.82
220UF/300V	4.00	3.65	3.35	3.10
5000UF/55V	1.90	1.80	1.70	1.65



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50UF x 50UF @ 500 VOLTS	7.45	6.95	6.70
100UF x 100UF @ 500 VOLTS	8.95	8.20	7.75
Mounting bracket/clamp	1.40	.90	.65

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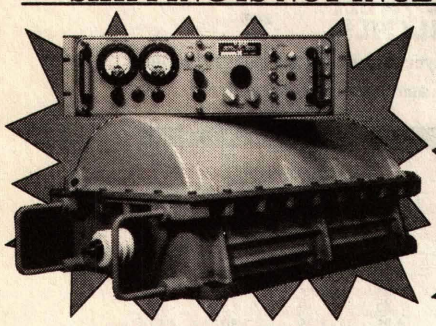


HARRIS RF-601A ANTENNA COUPLER GROUP

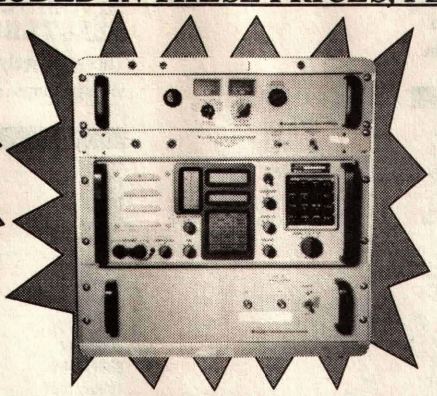
Ruggedly designed to meet any weather conditions head-on. This 1 KW manual/automatic coupler is solidly constructed out of die-cast aluminum and the internal cavity is pressurized with inert nitrogen gas. It covers 2-30MHz and electrically couples the transmitter with the antenna. It comes with the RF-601A/C coupler control unit. No expense was spared at $12k a piece original gov't cost.
Your Price: $1,150.00 ea.

HARRIS RF-551A PRE/POSTSELECTOR

Covers 2-30MHz via frequency controls on front panel or it can be remotely controlled via digital interface (installed). These units have an average 5-10db gain and exhibit excellent rejection outside of selected the frequency.
Excellent condition. **Price: $495.00**

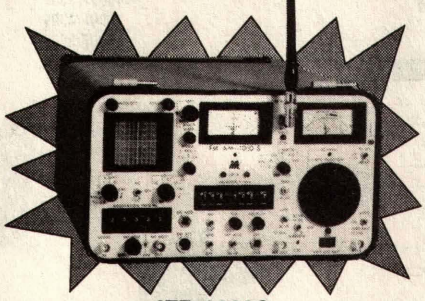
HARRIS RF 131-122 EXCITER

This exciter is compatable with the RF-110 pwr amplifier. It features digital tuning with remote control capability in the 2-30MHz range at 100Hz increments. Modes of operation are U/LSB, compatable AM, CW and ISB. These units are in excellent physical condition and exhibit no apparent faults. **Price: Untested $750.00**



CUBIC COMMUNICATIONS FIELD TRANSPORTABLE HF/SSBTRANSCIEVER

RT-1393/USQ is a solid state transceiver capable of continuous coverage from 1.6 - 30 MHz in 100 Hz steps. It offers simplex, semi-duplex modes and is capable of U/LSB, CW, AM, and ISB. Filter bandwidths are 2.4kHz, 1.8kHz, 500Hz and 6kHz for AM operation. 100 channels can be programmed into memory which lends itself nicely to the scanning of favorite freq's. Power output is 100W PEP power requirements are 20-32Vdc or 115/230Vac. **Price: $3,200.00 ea.**



IFR 1000S COMMUNICATIONS MONITOR

AM/FM-1000S is a synthesized AM/FM/SSB receiver/signal generator with a built-in spectrum analyzer. Frequency range is 300Khz-1Ghz, it contains a 60 watt rf power meter, deviation/modulation meter, oscilloscope, tone generator and internal high stability freq-standard. Its a radio repair shop in one cabinet.
Price: $4750.00 Fully Checked (new crt).

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Please include telephone/fax # with mail-in orders. Orders must be prepaid by guaranteed instrument.
Prices do not include shipping.
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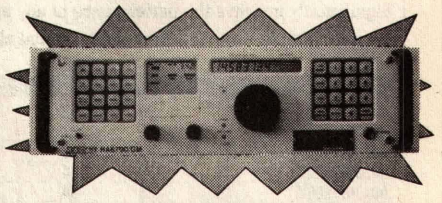
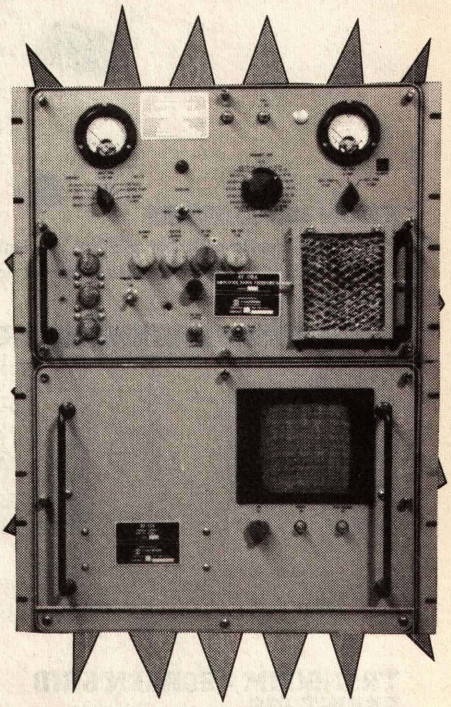
Manuals available at extra cost



RACAL RECEIVER RA 6790/GM

This 500kHz-30MHz general coverage receiver's modes of operation are AM, FM, CW, U/LSB, with room for seven bandpass filters. LCD's display frequency and mode status as well as AF or RF levels. Tuning is via keypad entry or tuning knob.
Price:$535.00 Not Checked, no filters available with this as-is unit. (manual $39.00).
Price:$995.00 Fully Ch'ckd, repaired,manual inc.
Filters: $65.00 ea. 400Hz, 1.2, 6.8, 16KHz.



HARRIS RF-124, RF-110 1KW POWER AMPLIFIER

This transmitter covers 2MHz-30MHz in 100Hz increments. Available modes of operation are SSB or AME, compatable AM, CW, ISB. It's complete with a pair of 4CX1500B final output power tubes and is supplied with a power supply RF-124. Operates on 230 Vac 48-63Hz 1 phase these units are in good physical condition.We don't guarantee it but, to date-none sold have been bad! not tested.
Price: $2,950.00 -shipping weight: 350 lbs.

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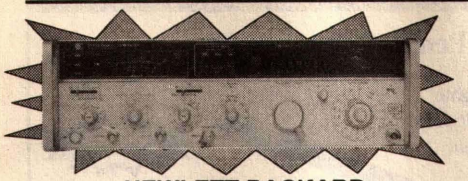

HEWLETT PACKARD 8640B SIGNAL GENERATOR

This Industry Standard signal generator covers 500Khz-512Mhz. It features internal phase-lock, digital freq readout, low SSB phase noise and cavity tuned oscillator. A state-of-the-art spectrally pure final amplifier goes from +19dBm -145dBm output. It comes with rev-power protection (opt-003) & extended audio oscillator range (opt-001).AM,FM and Pulse modulation. **Special Price: $2395.00**

HARRIS RF-590

If you want to own **a professional** receiver that meets MIL-STD-188C and exhibits performance spec's beyond your wildest dreams, you may want to consider the "590"!! This puppy comes loaded with all the bells and whistles: like a bright easy-to-read green fluorescent display, precision machined tuning knob, tactile full function keys and advanced "BITE" self test diagnostics plus, it sports exceptionally good looks to boot. This unit ***has it all*** starting with 1Hz tuning resolution over the entire 10kHz-30MHz frequency range. It can store, in memory, up to 100 channels of frequency mode, filter bandwidth, AGC time constant and BFO offset. The following full compliment of filters are included: 3.2kHz USB/LSB/ISB, 16kHz FM, 1.0&0.3kHz CW, 16 / 6 and 3.2kHz AM. AGC modes are: data/ slow/med/fast, plus its fully remote controllable via RS-232 or RS-422.

Wait....there's more...like a built-in speaker, squelch control, high stability ovenized frequency standard, green fluorescent alphanumeric "mode" display and American made quality through-out. All RF-590s are fully checked, burned-in and guaranteed for 30 days.

VERY GOOD CONDITION.....$2250.00

SELECTED EXCELLENT CONDITION..$2750.00

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Superior QUALITY plus rugged design are features of this deluxe 2 cylinder 4 stroke gasoline generator. The control panel contains meters for voltage & current indication, main circuit breaker and voltage adjustment. Shielded wires and plugs comprise the RFI suppression ignition system eliminating most radio noise. These units are "**new unused**" in the original carton complete with operators manual and only require fuel and oil for operation; output voltage is adjustable approx. 10-32v (28v nom) @ 53.3A (1.5Kw) continuous duty load.

Price: $399.00 New in Orig. Carton.
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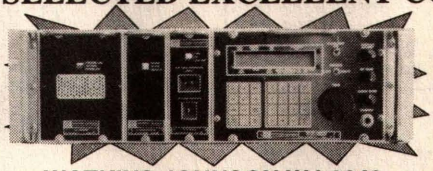

WATKINS JOHNSON WJ-9040 SERIES RECEIVER

This awesome radio covers 200Hz-1400MHz in 13 bandwidths of AM, AM Slideback, FM,CW and SSB demod modes. The system consists of 4 receivers in one rack, rec/1 200Hz-1.5kHz, rec/2 1.5-20MHz, rec/3 20-500MHz, rec/4 500-1400MHz. IF output is 21.4MHz Backlit alpha-numeric LCD display RF/ AF gain tuning knob and keypad for direct data entry. Contains lots of features and you can bet this is a super-rare find.

Fully checked good condition Price: $4990.00
CALL for DETAILS!!!

PRC 25 - MILITARY TACTICAL TRANSCEIVER

Fabulous quality and design are standard in this 30Mhz-75.95 Mhz tactical transceiver. Output power level from 1.1 - 2 watts, 150Hz squelch tone. The units we received are **reconditioned** (newly painted) ready for issue and include the battery box. **Price: $245.00**

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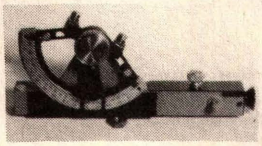

CUSHMAN SERVICE MONITOR MODEL 4000 w/ SPECTRUM ANALYZER 50kHz to 1GHz Price: $4,500.00

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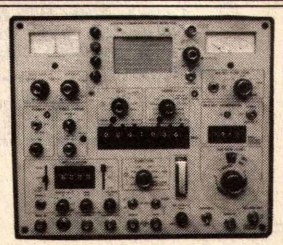

CUSHMAN SERVICE MONITOR MODEL CE50A w/ SPECTRUM ANALYZER

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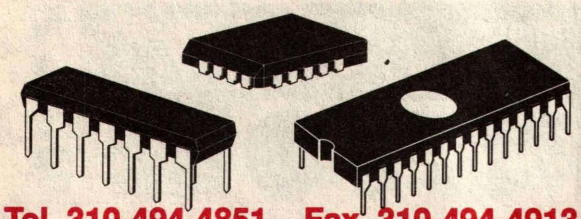

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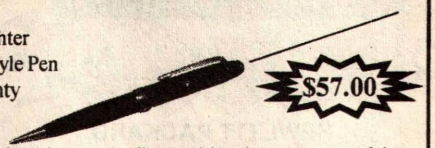

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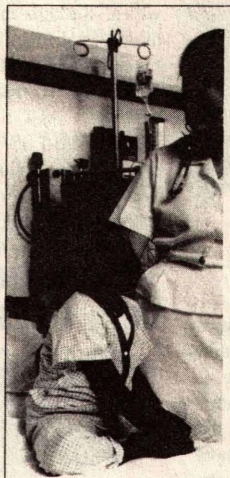

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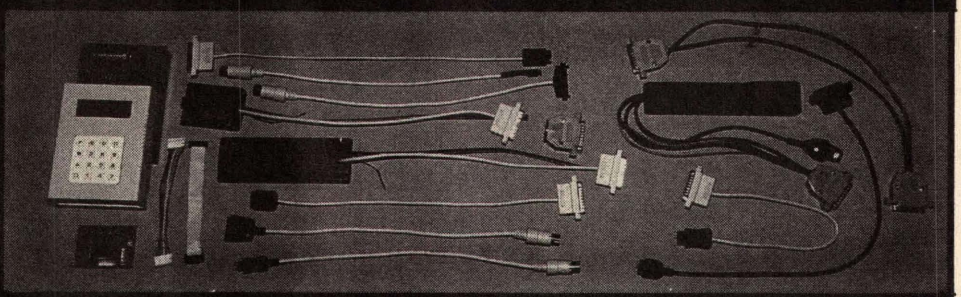

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*** Requires purchase of first years' programming ($300) 50 Channels including The Disney Channel and many more!**

Finally! Digital Picture and Sound at an unbelievable price! If you've been wanting an 18 inch digital broadcast satellite system now is the best time to buy! The DISH Network Digital Broadcast Satellite System utilizes true MPEG-2/DVB and has a fast 32 bit microprocessor! This system has all of the bells and whistles including "V-Chip" Parental Control, On-screen programming guide and much, much more!

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Part #: 2110 $59.95

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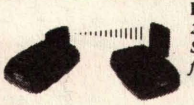
Includes everything you'll need to install the DISH Network satellite dish system including a comprehensive instruction manual and step-by-step video tape

Part #: 73457 $54.95



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2.4 GHz transmission allows you to send interference-free Stereo Audio and Video signals up to 300 feet away! Ideal for satellite or any existing A/V component

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AUDIO AMPLIFIERS

We have a selection of proven designs from 8 to 50 watts, available as kits or fully assembled and tested. One is sure to fit your needs for quality audio in the car or home. These are all designed for a nominal 1Vpp (line level) incoming audio signal. **OUR AMPS ARE ALL RATED in WATTS RMS PER CHANNEL INTO 4 OHMS.**

BABYBOOMR $69.95

50 watt subwoofer amp for car audio

Don't let the name fool you! It won't blow out the windshield but it packs a hefty punch! INCLUDES CASE AND POWER SUPPLY, begins to clip at 50 watts rms. Features input summing network for drive from L+R channels, 3rd order (18dB) active low-pass filter, input level adjustment and 50watt power amp section. As supplied cuts off at 100Hz, can be easily changed to 80 Hz. Distortion is under .1% to 49 watts rms into 4 ohms. Output section features thermal and overload protection to prevent self-destrution if you try to drive it too hard, and turn-on delay to reduce/eliminate annoying thumps. Flat within 3dB to 20Hz or below. Not intended for 2 ohm loads or bridging, the best way to get more out of it is to drive a pair of 8 ohm subs (the bigger the better!) in parallel. Also available assembled and tested, add $35.00. Good for intermediate builders.

ROOMBOOMR $79.95

50 watt subwoofer amp for home audio

The BabyBoomR moves indoors ! Includes heatsink and power supply but no cabinet. Super addition to your surround sound, multimedia computer sound or main audio system. This one will rattle the walls in a large room - even a room or two away from the speaker ! Same features and performance as the BabyBoomR. Will drive an 8 ohm load, best results obtained by running a pair of 8 ohm subs in parallel (preferably 10" or bigger for large rooms or loud parties). Also available assembled and tested, add $35.00. Not recommended for first-time builders.

S1514Kit $89.95

2 channels of 50 watts for car audio

INCLUDES CASE AND POWER SUPPLY. Each channel delivers a clean 50 watts rms into a four ohm load, clipping begins at about 48 watts. Under that distortion stays within .1% typically. Flat response from 20Hz to 20KHz, on-chip protection for thermal and overload conditions, also features turn-on delay to reduce/eliminate thump. Not intended for bridging or 2 ohm loads, but may blow the cones out of original oem speakers. Assembled and tested add $35.00, good for intermediate builders but not recommended as a first project.

S3886Kit $89.95

Dual 50 watts for home audio

Perfect for gutsy multimedia system for the computer or as the second amp for a surround-sound system. puts around 35 watts into 8 ohms, 50+ watts into four ohms with typically .1% distortion or less. Flat response from 20Hz to 20KHz, features thermal and overload protection, turn-on delay etc. Basically the "in-home" equivalent to the S1514Kit. INCLUDES POWER SUPPLY and HEAT SINK but no cabinet. Available assembled and tested, add $35.00. Not recommended as a first project, but good for novice to intermediate builders.

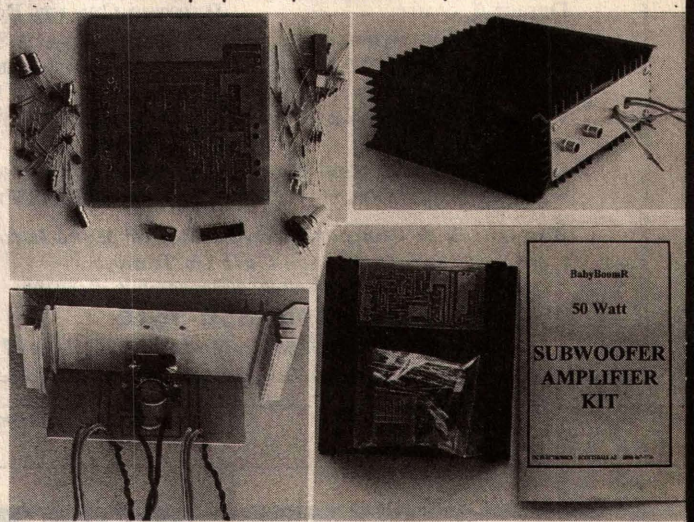
S1554Kit $19.95

Dual 22 watts for car or home

As featured in February 1997 *Popular Electronics* article. Supplies two channels at 22 watts each into 4 ohms, around 15 watts into 8 ohms with low distortion. Operates directly from your car battery or requires 12 VDC, 2Amp power supply for in-home use (PS-A4 available for $19.95). Suitable for beginners with good soldering skills and a fine-tipped iron.

M2002Kit $9.95

A good first kit, this design is based on the venerable LM383T/TDA2002 IC. Unlike our other audio kits, this one is extremely high gain. Ideal as a drop-in audio section for scanners, small radios or other projects requiring a single audio channel. Output power up to 8 watts. Requires 12 to 18 VDC.



FM TRANSMITTERS

STEREOCASTER $29.95

One of the best buys available for low-powered FM broadcasting. Can be tuned in the 88-108MHz standard FM broadcast band, loaded with features like front-panel fine-tuning, crystal-controlled subcarrier for stereo, and an RF output amplifier stage for increased range. Stable enough for use with digital tuning receivers, can be operated from 9V battery or optional power supply available separately (PS-3, $ 9.95). Based on the BA1404 IC, provides music-quality broadcast.

1 CHIP AM RADIO 80-630 $14.95

Good school project, 1 IC serves as RF amp, detector, AGC and audio amp, followed by 2 stage audio amp that drives a 3" speaker.

2 STAGE FM TRANSMITTER 80-320 $9.95

Tuneable in upper FM band, extremely sensitive mike, range to 1/2 mile

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YOUR MANUFACTURER OF HIGH QUALITY KITS
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- Powerful 2 stage audio amplifier.
- Tunes 88-108 MHz.
- Up to 1 mile range.
- Requires 9V battery. (Not incl.)
- Sensitive, picks up sounds at the level of a whispef.

SUPER-MINIATURE FM TRANSMITTER
Super small FM transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.
XST500 E-Z Kit $49.95

- Sensitive audio amplifier, picks up sounds at the level of a whisper.
- Tunes 88-108 MHz.
- Up to 1/2 mile range.
- Miniature photo battery mounts right on circuit board. (Included)

MICRO-MINIATURE FM TRANSMITTER
Including the battery, this is the Worlds smallest FM transmitter. Use with any FM broadcast receiver. Easy to assemble, uses pre-assembled circuit board.
XWB1000 E-Z KIT $46.95

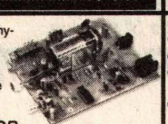
- Up to 1/2 mile range.
- Miniature photo battery mounts right on circuit board.
- Transmits at 143 MHz.
- Amazing audio sensitivity, picks up sounds at the level of a whisper.

CRYSTAL CONTROLLED FM TRANSMITTER
Including the battery, this is the Worlds smallest crystal controlled FM transmitter. Transmits to any scanner type receiver. Easy to assemble, uses pre-assembled circuit board.
XTL1000 E-Z KIT $69.95

- Transmits a continuous beeping tone.
- Transmits at 143 MHz.
- Up to 1 mile range.
- Works with most any scanner type receiver.

TRACKING TRANSMITTER
Only 0.75 by 1.8 inches including the battery, the XTR300 is ideal for use in locating lost model rockets, bicycles, automobiles, games of hide and seek, and contests.
XTR300 E-Z Kit $79.95

- Dial your phone from anywhere and listen to the sounds inside your home.
- Two digit Touch Tone code for secure operation.

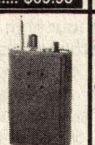


TELEPHONE SNOOP
The latest in home or office security. Call home from anywhere, enter a two digit security code, and hear the sounds in your home. Automatically turns on without ringing the phone, verifies code, then activates for one and a half minutes.
XPS-CASE KIT $14.95
XPS1000 C KIT $55.95

- Smallest Phone transmitter anywhere!
- Tunes 88-108 MHz.
- Up to 1/4 mile range.
- Attach to phone line anywhere in house.
- No batterie required, powered by phone line.

SUPER-MINIATURE PHONE TRANSMITTER
Worlds smallest FM phone transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip components are pre-assembled to the circuit board.
XSP250 E-Z Kit $34.95

- **Professional quality.**
- Uses new Microwave Integrated Circuit amplifier.
- Assembly is a snap.
- Covers 1 to 2,000MHz.
- Adjustable sensitivity.
- Audio jack for privacy ear phone.



SUPER SENSITIVE BUG DETECTOR
Any intercepted signal causes an audio tone that increases from a low pitched growl to a high pitched squeal as you get closer to the source of the signal.
XBD500 E-Z Kit $129.95

- Use with any FM broadcast receiver.
- Hear every sound in an entire house!
- Up to 1 mile range.
- Powerful 2 stage audio amplifier.

MINIATURE FM TRANSMITTER
The XFM100 has a super sensitive microphone and is capable of picking up sounds at the level of a whisper and transmitting them to any FM broadcast receiver.
XFM100 C Kit $21.95

- Will analyze live voice best, but will work over the phone, and even from recordings
- Has built in microphone.
- Easy to use LED output display.
- Voice-stress analysis instantaneous.

VOICE-STRESS ANALYZER
SEE THROUGH LIES AND DECEIT! This is the latest breakthrough in voice-stress analysis. Know if someone is under stress such as when telling a lie
XVA250 C Kit $49.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Use with any modular phone.
- 16 levels of voice masking.
- Connects between handset and phone.

VOICE CHANGING ACCESSORY
STOP THOSE ANNOYING TELEPHONE CALLS!
Sound older and tougher when you want to. Not a kit. Fully assembled. Use with single or multi-line phones.
TRANSITION 2001 ..... $69.95

- Uninterrupted coverage of 800 to 950 MHz.
- Works with any scanner that can receive 400 to 550 MHz.

800-950 MHz SCANNER CONVERTER KIT
If your scanner can receive 400-550 MHz, just add the XLC900 for ***uninterrupted 800-950*** MHz coverage. It converts all 800-950 MHz signals down to 400-550 MHz so your scanner can receive them! Add our custom case kit for that "Professional" look.
XLC-CASE KIT $14.95
XLC900 C KIT $49.95

- Transmit high quality stereo to any FM stereo receiver.
- Built-in output level monitor for quick and easy tuning.
- Ideal for use with personal CD player.

FM STEREO TRANSMITTER
Transmit full-bodied Hi Fi stereo to any FM stereo receiver. Separate left and right inputs and gain controls. Includes an output booster stage for greater range.
XFS-CASE KIT $14.95
XFS108 C KIT $39.95

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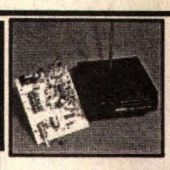
RAMSEY

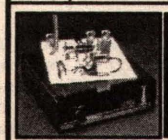
Synthesized FM Stereo Transmitter



Microprocessor controlled for easy freq programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit $129.95

Tunable FM Stereo Transmitter



A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit..... $34.95
CFM, Matching Case and Antenna Set..... $14.95

RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional matching case set.

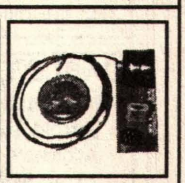
LPA-1, Power Booster Amplifier Kit..... $39.95
CLPA, Matching Case Set for LPA-1 Kit..... $14.95
LPA-1WT, Fully Wired LPA-1 with Case..... $99.95

Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

FM-5 Micro FM Wireless Mike Kit..... $19.95

Crystal Controlled Wireless Mike

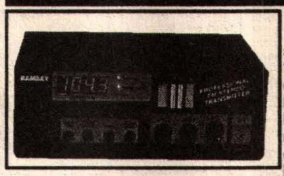


Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

FM-6, Crystal Controlled FM Wireless Mike Kit..... $39.95
FM-6WT Fully Wired FM-6 ..... $69.95

Call for our Free Catalog !

Super Pro FM Stereo Radio Transmitter



A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes sharp looking metal cabinet, whip antenna and 120 volt AC adapter. Also runs on 12 volts DC.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit $299.95
FM-100WT, Fully Wired High Power FM-100..... $429.95

Speech Descrambler Scrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. The technology used is known as speech inversion which is compatible with most cordless phones and many police department systems, hook it up to scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC, RCA phono type jacks. Our matching case set adds a super nice professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit..... $39.95
CSS, Custom Matching Case and Knob Set $14.95
SS-70AWT, Fully Wired SS-70A with Case..... $79.95
AC12-5, 12 Volt DC Wall Plug Adapter $9.95

Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

TG-1, Tone Grabber Kit..... $99.95
CTG, Matching Case Set for TG-1 Kit..... $14.95
TG-1WT, Fully Wired Tone Grabber with Case..... $149.95
AC12-5, 12 Volt DC Wall Plug Adapter..... $9.95

Mini-Peeper Micro Video Camera

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MP-1, Wide Angle Lens CCD TV Camera Outfit..... $169.95
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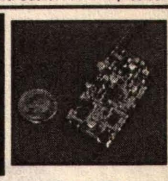
MicroStation Synthesized UHF TV Transmitter



Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

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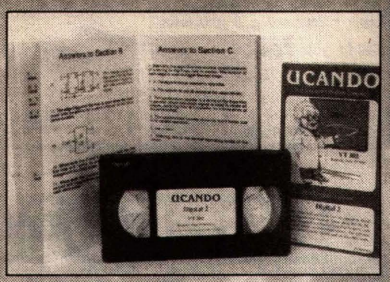

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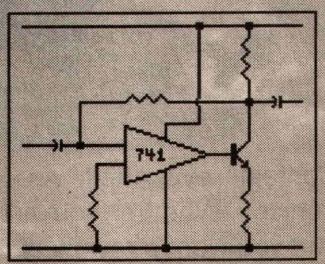

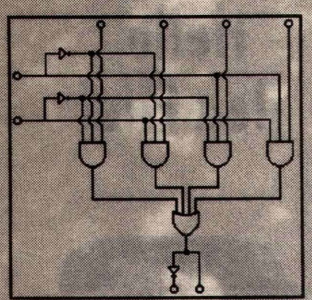

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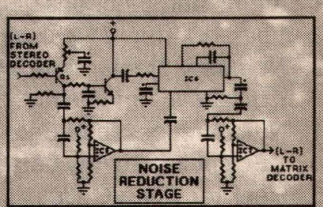

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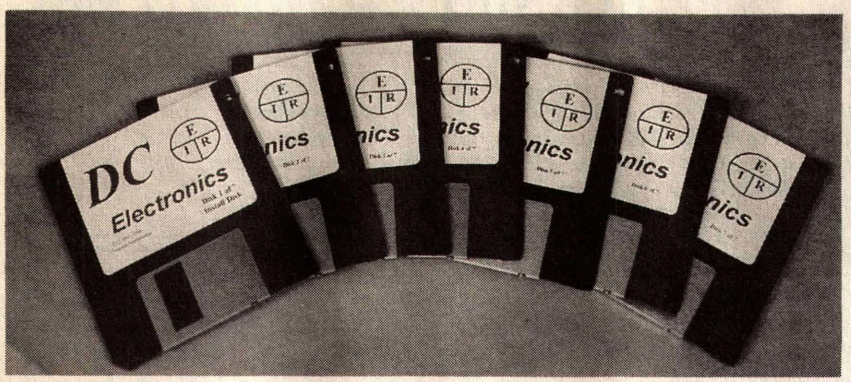

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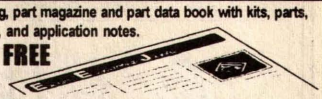

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motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

CAMERA BLOCK $99.00 or 2 for $169.00
FOR ROBOTICS AND EVERYTHING ELSE
Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. **NOTE:** We have Composite or PAL (European Standard) Units. **MFR: SONY**

CELL SITE TRANSCEIVER $79.00 2 for $149.00
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

POINT OF SALE BANK TERMINAL $39.00 or 2 for $69.00
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

.6" COMPOSITE MINIATURE COLOR DISPLAY $99.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal.
250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

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Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
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Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

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XK-550 Digital / Analog Trainer

Elenco's advanced designed Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator with continuously sine, triangular and square wave forms.
1560 tie point breadboard area.

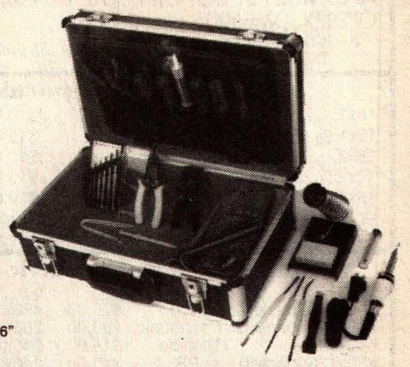
XK-550
Assembled and Tested
$169.95

XK-550K - Kit
$139.95

Tools and meter shown optional

TK-3000
$89.95

Tools Included:
- SR-2 - Deluxe Soldering Iron
- SH-1 - Soldering Iron Stand
- ST-1 - Diagonal Pliers
- ST-2 - Long Nose Pliers
- ST-30 - Deluxe Wire Stripper
- SE-1 - Solder Ease Kit
- ND-3 - 3 pc. Nut Driver Set
- TL-8 - Precision Screw Drivers
- ST-5 - Screw Driver Slotted 3/16"
- ST-6 - Screw Driver #1 Phillips
- ET-10 - IC Puller
- SP-2 - Solder Pump
- ST-20 - Safety Goggles
- ST-9 - Pocket Screw Driver
- ST-4 - Solder Tube
- SW-3 - Solder Wick



A professional technician service tool kit in a metal reinforced tool case with heavy-duty handle and locks. A removable pallet handles most of the tools listed with more room for tools and parts in the lower half.

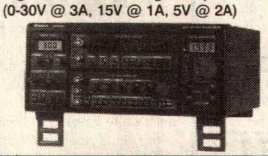
GF-8026 w/ Frequency

- Linear and Log Sweep
- .02Hz to 2MHz
- Counter Range 1Hz to 10MHz
- 4 Digit Display

$225

MX-9300 Four Functions in One

- One instrument with four test and measuring systems: 1.3GHz Frequency Counter • 2MHz Sweep Function Generator Digital Multimeter • Digital Triple Power Supply (0-30V @ 3A, 15V @ 1A, 5V @ 2A)

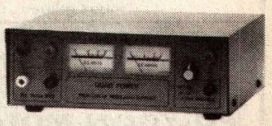


$479.95

Model XP-581

4 Fully Regulated DC Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
1 Variable - 2.5 - 20V @ 2A

$85



Auto Ranging Hand-Held
DMM w/ Bar Graph
Model EDM-163

$99.95

7 Functions with data hold
Compares to Fluke Model 77II

Digital Multimeter
Model M-1700

$39.95

11 functions including freq to 20MHz, cap to 20µF. Meets UL-1244 safety specs.

Fluke Multimeters

70 Series		80 Series	
Model 70II	$69.95	Model 83	$235.00
Model 73II	$97.50	Model 85	$269.00
Model 75II	$135.00	Model 87	$289.00
Model 77II	$154.95		
Model 79II	$175.00		

B&K Precision Multimeters

Model 391	$159.00	Model 388A	$99.00
Model 390	$139.00	Model 2707	$79.00
Model 389	$109.00	Model 2860A	$85.00

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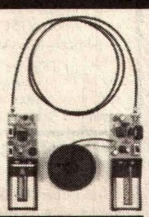
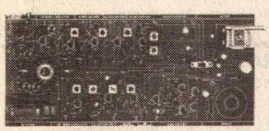
over 100 kits available

PT-223K
$15.95
Phone kit with training course.

Fiber Optics Technology
with training course
Model FO-30K
$19.95



Model AM/FM-108K
Transistor Radio Kit
with training course
$29.95



M-1005K
Compact Multimeter Kit
$19.95
6 Functions & Transistor Test

Model M-6100
Programmable DMM

Includes FREE Computer Interface and FREE Software
- Analog Bar Graph
- Large 3 3/4" LCD Display
- Menu Driven
- Triple Display
- RS-232 Interface
- True RMS
- 9 Basic Functions including cap. & freq.
- Auto Power Off
- Easy-to-use

$125

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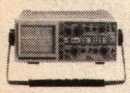
B&K Precision Scopes

60MHz ANALOG WITH DIGITAL STORAGE
Model 2560
- Cursors and readouts
- RS-232 port
- 20MS/s real time sampling
- 1GHz equivalent time sampling (at 0.1µs/div.)
- Prints via RS-232 port to any HP-GL plotter



$1995

20MHz ANALOG WITH DIGITAL STORAGE
Model 2522A
- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2K memory per channel
- 300MHz equivalent time sampling
- Pre-trigger capture

$869.95

100MHz THREE-TRACE
Model 2190A
- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- 15KV accelerating voltage

$1379.95

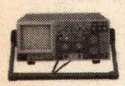
60MHz DUAL-TRACE
Model 2160A
- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

$949.95

40MHz DUAL-TRACE
Model 1541C
- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester

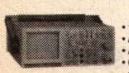
$695

60MHz, CURSORS & READOUTS, DUAL TIME BASE
Model 2260
- Cursors and readouts
- 1mV/div sensitivity
- 23 calibrated ranges - main time base
- 19 calibrated ranges - delayed time base
- Signal delay time
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep

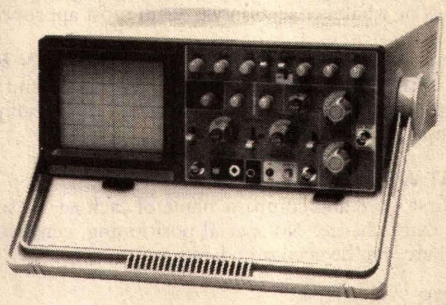


$1225

20MHz DUAL-TRACE
Model 2120 - 2 Year Warranty
Special $389.95
Model 2125 with delayed sweep
$539.95
- 1mV/division sensitivity
- AUTO/NORM triggered sweep operation
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design



Quality Scopes by Elenco



60MHz

DS-603 $1350
- Analog / Digital Storage
- 20MS/s Sampling Rate

S-1360 $749
- Analog with Delayed Sweep

40MHz

S-1345 $569
- Analog with Delayed Sweep

S-1340 $475
- Analog

25/30MHz

DS-303 $1095
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

S-1325 $325
- 25MHz Analog

2 Year Warranty

OSCILLOSCOPE SELECTION CHART

ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

Affordable Spectrum Analyzers by B&K

500MHz Series
Model 2615 - **$1595**
Model 2620 w/ tracking generator - **$1895**

1.05GHz Series
Model 2625 - **$2395**
Model 2630 w/ tracking generator - **$2995**

HURRY... AT PRICES THIS LOW THEY'LL BE GONE FAST!

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Inventory Reduction Sale
Lowest Prices of the Decade!

V-209 - 20MHz Battery Operated
Was $1505, NOW **$1095 Save $410**

V-422 - 40MHz Was $965,
NOW **$765 Save $200**

V-525 - 10MHz w/ Cursors
Was $1355, NOW **$955 Save $400**

V-552 - 50MHz Was $1195,
NOW **$850 Save $345**

V-555 - 50MHz w/ Cursors
Was $1375, NOW **$975 Save $400**

V-695 - 60MHz w/ Cursors
Was $1815, NOW **$1395 Save $420**

V-1065A - 100MHz w/ Cursors
Was $2139, NOW **$1565 Save $574**

V-1560 - 100MHz Was $1790,
NOW **$1490 Save $300**

V-1565 - 100MHz w/ Cursors
Was $1960, NOW **$1595 Save $365**

V-252 - 20MHz **$419**

Fluke Scopemeters

91 . . . . . **$1225**
92B **$1445**
96B **$1695**
97 . . . . . **$1795**
97A **$2945**
99B **$2095**
Call or write for complete specs.

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INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues. **Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word. Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics
130 -- Audio-Video Lasers
160 -- Business Opportunities
190 -- Cable TV
210 -- CB-Scanners
240 -- Components
270 -- Computer Equipment Wanted
300 -- Computer Hardware
330 -- Computer Software
360 -- Education
390 -- FAX
420 -- Ham Gear For Sale
450 -- Ham Gear Wanted
480 -- Miscellaneous Electronics For Sale
510 -- Miscellaneous Electronics Wanted
540 -- Music & Accessories
570 -- Plans-Kits-Schematics
600 -- Publications
630 -- Repairs-Services
660 -- Satellite Equipment
690 -- Security
710 -- Telephone
720 -- Test Equipment
730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #_____ **Special Category $30.00 Additional** _____

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00
29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00

Total words _____ $2.50 per word = $_____

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Special Heading _____ $30.00 = $_____

Other _____ = $_____

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TOTAL COST OF AD $ _____

[ ] Check [ ] Mastercard [ ] Visa [ ] Discover Card # _____ Expiration Date __/__

Signature_____

Name _____ Phone _____

Address_____ City State Zip _____

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New educational kits for learning and more fun!

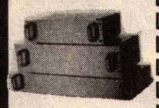
Free Catalog 213/888-8988 Fax 213/888-6868

Order 1-800-521-MARK / 1-800-423-FIVE

Kit skill levels are specified as ▲ beginner ▲▲ intermediate or ▲▲▲ advanced!

Best Buy

Metal Cabinets with Aluminum Front Panel



LG-1273	3x12x7"	$ 26.50
LG-1684	4x16x8"	32.50
LG-1924	4x19x11½"	38.25
LG-1925	5x19x11½"	42.00
LG-1983	2¼x19x8"	35.25
LG-1923	3x19x11½"	36.50
LG-1927	7x19x11½"	50.50

LG- Black anodized rack cabinet

New

*LL-1923B	2¾x19x12"	69.50
*LL-1925A	5x19x12"	79.50

*LL- High quality full Aluminum Cabinet
*LL- Front panel .157" & other panels .078"
*LL- Gold plated cap screw for front panel
- **Dimensions in inches ±.05**
- **Custom-made for other dimensions if over 100 pcs for single model !**

Modular Desktop Consoles

	L x W x H	
LE-453	4x4¾x3"	$ 7.50
LE-653	6x4¾x3"	9.75
LE-853	8x4¾x3"	11.75

LE- Black finished aluminum panel 1mm thick.

Camera Housing

*LD-1244	2¾x10¾x4"	$55.00
**LD-1516	3¾x13¾x4"	29.50
**LD-1565	4x13¾x5¼"	31.75

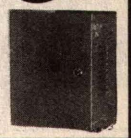
*LD- Stainless Steel 0.7mm
**LD- Sheet Metal 1mm

Alarm Box with Lock

Mejor Compra !

LB-1085	8¼x10¼x5"	$18.75
LB-1395	9¼x13¼x5"	25.50
LB-1525	12¼x15¼x5"	35.25
*LB-1494	9¼x14¼x4¼"	21.50
LB-1383A	8½x13¼x4"	23.25

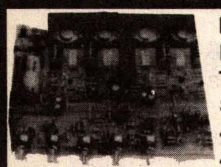
*No lock & LB- Sheet Metal 0.8mm



Power Transformers &**Toroidal Transformer

001	28/30V x 2	6A	$ 30.00
002	36V x 2	3A	25.00
003	40V x 2	6A	32.00
**008	28/30V x 2	6A	40.00
**009	48/53V x 2	8A	66.00
**012	33/40/42Vx2	6A	48.00

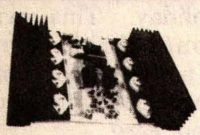
TA-800MK2 ▲▲ 120+120W Pre & Main Stereo Amp. (4 lbs.)



Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

AF-3 ▲▲▲ 300W MOSFET High Power Mono Amp. (7 lbs.)



Kit:$ 165.00 Asmb.$ 195.00

Power Output: 300W into 4 ohms RMS. 200W into 8 ohms RMS. Frequency Response: 10HZ-20KHZ. THD: <0.03%. Signal to noise ratio: 91dB. Input Sensitivity & Impedance at 1KHZ, 1V 47K. Load Impedance 4-16 ohms. Power Requirement: ±55 to ±65VDC 8A. Suggested Mark V model 009 Transformer. Capacitor 10,000uf 80-100V model 016 or 019. Recommended Metal Cabinet LG-1925 for each channel.

TA-388 ▲▲▲ Class A FET Dynamic Buffer Stereo Pre-Amp (1 lb.)

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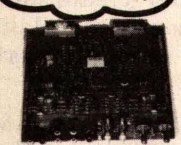
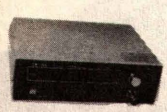


Kit:$64.00 Asmb.$ 80.00

Frequency Response (at rated output): Overall 10HZ-100KHZ +0.5dB-1dB. THD: Overall <0.007% at or below rated output level. Channel Separation (at rated output 1KHZ): Overall better than 70dB. Hum & Noise: Overall better than 90dB. Input Sensitivity (1KHZ for rated output): 300-600mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 500mA.

SM-100 ▲▲▲ 150 MHZ 8 Digit Frequency Counter (2 lbs.)

Best Buy



Kit:$ 79.00
Asmb.$ 99.00

Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KHZ range 10HZ-10MHZ 20mV(min.). MHZ range 1MHZ-120MHZ 20mV(min.), 120MHZ-150MHZ 35mV (min.), 150MHZ-200MHZ 40mV(typical). Time Base: 10MHZ crystal, ±10 ppm. Input Impedance: 1M ohm. Response Time: 0.2s. Resolution: 0.1 HZ: 10s gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time, 100 HZ: 0.01s gate time. Hold the last input signal. Reset counter to 0. DC 9V power adapter not included.

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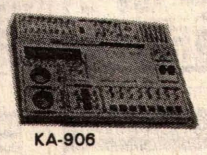

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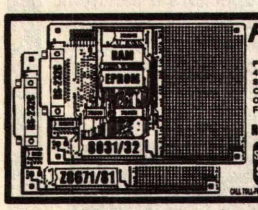

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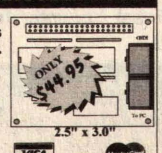

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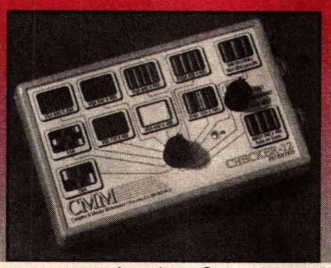

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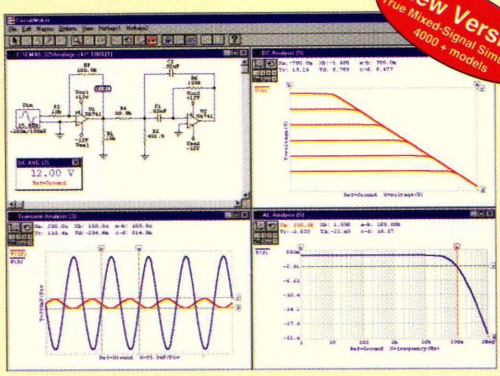

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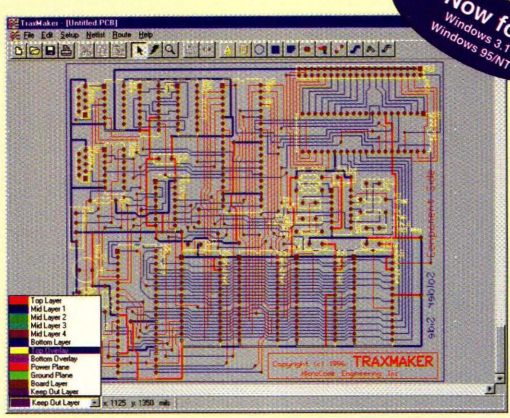

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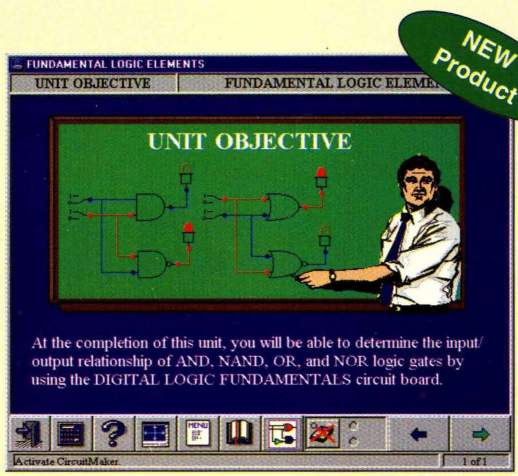
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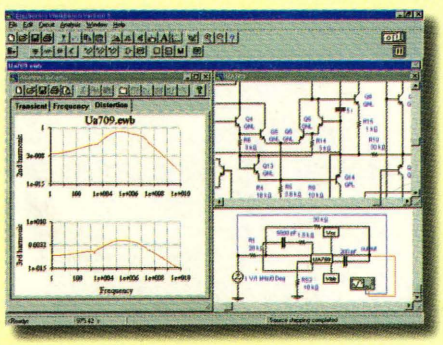

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Oscil[illegible]

[illegible]ors. Save data to ASCII file.

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